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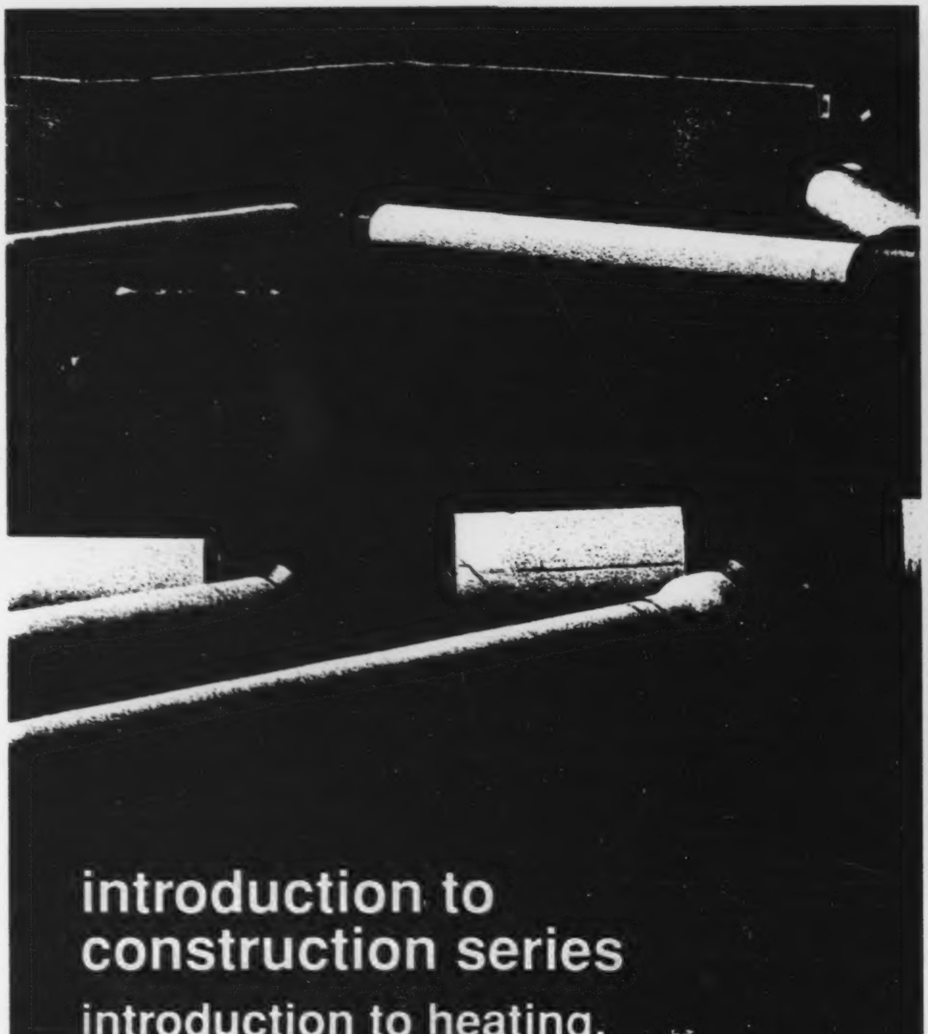
ABSTRACT

This instructor's guide contains the materials required to teach a competency-based introductory course in heating, ventilating, and air conditioning (HVAC) to students who have chosen to explore careers in construction. It contains three units: HVAC materials, HVAC tools, and applied skills. Each instructional unit includes some or all of the basic components of a unit of instruction: performance objectives, suggested activities for the instructor, extensions and options, information sheets, student supplements, transparency masters, instructional supplements, assignment sheets, job sheets, practical tests, written tests, and answers to assignment sheets and written tests. Academic skills training is combined with vocational training throughout the instructional materials, and a system of icons has been used to help instructors identify activities into which training in the following basic skill areas has been infused: reading, science, creative thinking/problem solving, writing, oral communication, employability, math, interpersonal skills, and social studies. Most units of instruction are designed for use in more than one lesson or class period of instruction. These materials precede the instructional units: information on basic skills in curriculum, information on measuring student performance gains, and required criteria for a competency-based education program. A competency profile and basic skills matrix are provided. (YLB)

ED 385 688



introduction to construction series

introduction to heating, ventilation and air conditioning (HVAC)

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Introduction to HVAC

Developed as a Cooperative Project by
the Associated General Contractors of America
Steve Hoech, Chairman, Manpower and Training Committee
and
Curriculum and Instructional Materials Center,
Oklahoma Department of Vocational and Technical Education

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Introduction to HVAC

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FOREWORD

In 1985, The Associated General Contractors of America (AGC) met with representatives of the Oklahoma Curriculum and Instructional Materials Center (CIMC) to discuss the possibilities of developing, as a cooperative project a course of instruction designed for training individuals who choose to seriously explore careers in construction.

This revised publication is the result of those original discussions and updates made through close coordination among general contractors and vocational educators. This series represents conscious effort to coordinate the practical experience of personnel in the carpentry industry with the best instructional methods of those in the field of vocational education.

Although this book reflects a systematic approach to instructional materials development and the latest in educational technology innovations, the information in the Introduction to HVAC manual should be adapted and modified to coincide with local conditions.

Roy Peters, Jr.
State Director
Oklahoma Department of Vocational
and Technical Education

Steve Hoech, Chairman
Manpower and Training Committee
The Associated General Contractors
of America

PREFACE

Construction requires that students have many skills and related information to become productive workers in this challenging field. Workers must be better trained and equipped to find and retain meaningful employment.

Instructional materials in this manual is written in terms of student performance, using measurable behavioral learning process. Criterion-referenced evaluation instrument provide for a uniform measurement of student progress.

The purpose of this manual is to assist instructors in all construction related areas in providing instruction throughout the industry. Any information in this manual that does not concur with the instructor's course of study should be modified to meet personal needs.

Personnel safety is of prime concern, as an instructor you are encouraged to closely observe and couch students in all safety issues. We have done much to advise students of possible dangers, but your close supervision and alertness can't be overemphasized.

Al Willey
Curriculum and Instructional
Materials Center
Oklahoma Department of Vocational
and Technical Education

ACKNOWLEDGEMENTS

Much appreciation is expressed to the many individuals who contributed their time, talents, and knowledge in the revision of this manual.

Thank you to the following ad hoc committee members, AGC staff representatives, and the staff of the Oklahoma Department of Vocational and Technical Education.

John Friedemann
CIMC Coordinator
Stillwater, OK
of America

William W. Brown, Chairman
Manpower and Training Committee
The Associated General Contractors

AGC Committee Members

Robert Siess
Tarlton Corporation
St. Louis, MO

Ralph E. Eggleston
Jaynes Corporation
Albuquerque, NM

Edward J. Hynds, Jr.
English Brothers Co. Inc.
Champaign, IL

Fernando Samarron
H.B. Zachry Co.
San Antonio, TX

Mike Lambert
Lambert Construction
Stillwater, OK

E.A. Proefke
Dunedin, FL

John Heffner
AGC - Manpower and Training Services
Washington, DC

Len Toenjes
Construction Training School
St. Louis, MO

Preston Leckie
Flintco Inc.
San Antonio, TX

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Instructional Development Specialist
CIMC - Oklahoma Department of Vocational and Technical Education

USE OF THIS PUBLICATION
INSTRUCTIONAL UNIT

Introduction to HVAC contains three units. Each instructional unit includes some or all of the basic components of a unit of instruction: performance objectives, suggested activities for the instructor, extensions and options, information sheets, students supplements, transparency masters, instructional supplements, assignment sheets, job sheets, practical tests, written test, and answers to assignment sheets and written test, all of which are included in the instructor's edition. The student workbook includes the objective sheets, information sheets, student supplements, transparency masters, assignment sheets, and job sheets. Written tests may be duplicated for classroom use or *additional copies* may be purchased by calling 1-800-654-4502 or, in Oklahoma, 1-800-522-5810, ext. 589.

All of the unit components tie into measurable and observable learning outcomes. Instructors are encouraged to supplement these components with other resources in order to make them as responsive to local conditions and individual needs as possible.

Most units of instruction are designed for use in more than one lesson or class period of instruction. Careful study of each unit of instruction by the instructor will help him or her determine the following:

- Amount of material that can be covered in each class period.
- Skills that must be demonstrated.
    - Supplies and equipment needed
    - Amount of class time needed for demonstrations
    - Amount of time needed for student practice
- Supplementary materials, including print and non-print media, that must be ordered.
- Resource people who must be contacted.

Objective Sheet (White Pages)

Each unit of instruction is based on the performance needed for successful employment in an occupational area. Performance objectives are stated in two forms. The unit objectives states the overall goal of the unit. It tells what the student should be able to do and what standard will be used to see whether the student can do it. Specific objectives outline the teaching sequence of the competencies required to meet the unit objective.

The objectives should be provided for students and stressed throughout the teaching/learning process. This will help answer any questions concerning performance requirements for each instructional unit. The objectives can also help determine teaching strategies and instructional methods. Instructors should prepare for each unit by deciding how each objective could be best taught.

Instructors should feel free to modify, delete, or add objectives in order to meet the needs of the students and community. When objectives are added, the instructor should remember to supply the needed information, assignment and/or job sheets, and criterion-referenced test items.

Suggested Activities (Pink Pages) — **Instructor's Edition only**

The suggested activities page assists the instructor during the preparation stage of the teaching/learning process by providing suggestions for delivery, application, and evaluation during the instructional process. The instructor should read the suggested activities prior to introducing the unit to allow time to obtain supplemental materials, prepare audiovisual materials, and contact outside resources. Duties of the instructor will vary according to the particular unit.

References used in the development of each unit are listed in the "Suggested Resources" section, along with print and non-print media that may be used to teach the unit. These materials can be used by the instructor to supplement his or her knowledge of the subject area or to help students with particular interests or occupational objectives in the area covered.

Extensions and Options (White Pages) — **Instructor's Edition only**

Extensions and Options are supplemental material that is not testable or graded and is nice-to-know. Extensions and Options provide the instructor with additional activities, fact sheets, art, controversial items, and extra practice sheets. They may also include items for the gifted or remedial student. Extensions and Options are used at the discretion of the instructor.

Information Sheets (Green Pages)

The information sheet provides "must know" content essential for meeting the cognitive objectives stated at the beginning of each unit. It serves as an excellent guide for presenting background knowledge necessary to develop the skills specified in the unit objective.

Students should read the information sheet before it is discussed in class. Space is provided in margins for students and instructors to add notes that clarify and/or expand on the information provided.

The information sheet may include notes, cautions, or warnings. These should be discussed carefully and thoroughly. **Notes** are short verbal additions to the information sheet or procedural outline that provide nice-to-know and decision-making information. A note may tell the student what to watch for or to consider at a given step. It may explain when a step may not be applicable. Notes offer guidance that may help the student understand the process and do it more efficiently. **Cautions** are advisories that tell the student how to avoid causing minor personal injury or equipment damage. **Warnings** are advisories to the student used to avoid serious personal injury or death to the student, persons in the workplace, or users of the project or the procedure.

Student Supplement (Green Pages)

Student supplements include instructions that could be used for solving problems or reinforcing the enrichment of learning. The information presented in a student supplement may consist of tables, charts, written information, forms, or other information students will need in order to complete one or more of the assignment or job sheets. While supplements are not tested over directly, they may be used to assist in meeting the performance objectives.

Transparency Masters (White Pages) — **Instructor's Edition only**

Transparency masters provide information in a special way. The students may see as well as hear the materials being presented, thus reinforcing the learning process. Transparencies may present new information or they may reinforce information presented in the information or assignment sheets.

Transparencies should be made and placed in the notebook where they will be immediately available for use. Transparencies direct the class's attention to the topic of discussion. They should be left on the screen only when topics shown are under discussion.

Instructional Supplements (Pink Pages) — **Instructor's Edition only**

Instructional Supplements provide suggestions for teaching the basic skills included in each assignment sheet or job sheet. They are located directly in front of the components they support—assignment or job sheets—in each unit.

Assignment Sheets (Tan Pages)

Assignment sheets provide students with information and exercises that address learning levels at or above the application level of Bloom's taxonomy. Assignment sheets provide written exercises for instruction and practice of a specific objective. The introduction to the assignment sheet explains how the assignment sheet relates to the subject area and unit component for such information.

Assignment Sheet Answers (Pink Pages) — **Instructor's Edition only**

This component is designed to assist the instructor in evaluating student performance on assignment sheets.

Job Sheet (Blue Pages)

Job Sheets are another important segment of a unit of instruction. The job sheets provide a list of equipment, tools, and materials needed to complete a manipulative or psychomotor skill. They describe a step-by-step procedure to complete each task or job. Diagrams, photographs, and illustration are provided to assist students in achieving the skill.

The instructor should demonstrate the procedure outlined in each job sheet. Furthermore, the instructor needs to localize the procedure according to the equipment and supplies available in the local lab or salon situation. Job sheets also furnish potential employers with a picture of the skills being taught and the performances they might reasonably expect from a person who has had this vocational instruction.

Practical Tests (Yellow Pages) — **Instructor's Edition only**

The practical tests are designed to assist the instructor in the evaluation of the psychomotor activities (job sheets). The practical test provides instructors with a valid mechanism for determining a student's level of ability in performing the procedure stated on the job sheet. The check-off list allows instructors to evaluate a student's process performance of the task on the job sheet. The overall competency indicator allows the instructor to evaluate the end product.

Written Test (Yellow Pages) — **Instructor's Edition only**

This component provides criterion-referenced evaluation of every objective listed in the unit of instruction. If objectives have been added, deleted, or modified, appropriate changes should be made on the test.

In order to measure and document student competency gains as required by the latest Carl Perkins regulations, and as outlined in the Oklahoma-developed system of standards and measures, it is *absolutely essential* that the same test be used as a pretest and as a posttest. If you choose to use tests other than the ones included herein, be sure that the same instrument is used for each activity—pre- and post test.

A detailed explanation of the Oklahoma plan for standards and measures and the Carl Perkins requirements is included in the CIMC publication, *Measuring Learning & Competency Gain: The Pretest/Posttest Approach.* This booklet and accompanying software designed to assist in calculating and recording student gains are available to all vocational teachers through the school's vocational testing liaison.

To further assist vocational teachers, the CIMC is in the process of developing test code sheets for each written test in its more recent publications, including this one. These code sheets are explained in Section 8 of the publication mentioned above, and will greatly assist in verifying that the test is a valid instrument for measuring student learning and competency gains. As the test code sheets for programs become available, they will be forwarded to teachers of each program; further publications will include the test code sheets.

Written Test Answers (Pink Pages) — **Instructor's Edition only**

This component is designed to assist the instructor in evaluating student performance on written tests.

COMPETENCY PROFILES

A competency profile is in the front of each publication. Competency profiles document student performance. The profile contains a list of the specific job competencies that a student should achieve before leaving the training program.

PAGE NUMBERING

Each publication for the Curriculum and Instructional Materials Center is usually assigned a specific abbreviation. ***Introduction to HVAC*** has not been abbreviated. Each unit will be recognized by the unit number in Arabic numerals. Each unit in the publication begins with page 1. Each page number gives the component name, Introduction to HVAC, unit number, and page number within the unit. Since some CIMC publications are loose-leaf, this system of page numbering was recently adopted so that pages from different manuals would not get mixed up. The page number for the objective sheet in Introduction to HVAC, which is unit 2, would look like this:

OBJECTIVE SHEET - **Introduction to HVAC**
CIMC - A2 - 1

METHODS OF DISSEMINATING MATERIAL

For best results, provide student materials for each student. Student workbooks contain objective sheets, information sheets, supplements, transparency masters, assignment sheets, and job sheets. Pretest, practical tests, and written tests are packaged separately for students, and can be stored until needed. Students should be allowed to take their materials home at the end of the course.

TEACHING METHODS

Keeping students motivated is a challenge. Supplement the objectives by providing the "why," personal experiences, and current information. If you are going to teach the material in a group setting, prepare for the unit be deciding the best way to teach each objective and allow for student input.

If you are going to follow the plan for individualized instruction, provide opportunities that will allow each student to become involved in planning for and being responsible for his or her own education.

CORRECTIONS AND SUGGESTIONS

The Curriculum and Instructional Materials Center (CIMC) wants to provide vocational instructors and students with materials that are accurate and effective. Although the CIMC strives to maintain the highest standards of development and production, oversights occasionally do occur. If you find any errors in this or other CIMC publications, or have suggestions for improving their usefulness in vocational programs, please notify the CIMC staff. One easy way of pointing out errors is to make a photocopy of the affected page and to indicate the correction on the copy. Mail this information to the CIMC, where it will be used to correct the publication before the materials are reprinted.

To ensure that the material is updated on a timely basis, notify the CIMC of necessary corrections as soon as possible after discovering the error. Do not assume that someone else will notice the error and inform the CIMC; other users may be making the same assumption. Please send corrections and recommendations for improving this publication to the following address:

Coordinator of Development
Curriculum and Instructional Materials Center
Oklahoma Department of Vocational and
Technical Education
1500 West Seventh Avenue
Stillwater, Oklahoma 74074-4364

For a free catalog, a list of new publications, or other instructional materials information call 1-800-522-5810, extension 589.

RESALE

BASIC SKILLS IN CURRICULUM

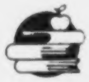
The CIMC has always been mindful of the importance of reinforcement (and sometimes remediation) of students' academic skills as they progress through vocational training, and has always included activities in its materials to enhance and promote use of these skills.

Recent state and federal legislation mandates vigorous basic skills development in vocational education in the wake of demands by industry that workers *must* be academically, as well as technically, competent, given the nature of the highly complex work place. In response, the CIMC has taken the following steps to document that, indeed, the instructional materials *do* combine academic skills training with the vocational training. In addition, concerted efforts have been made to "beef up," or enhance the basic skills instruction already present. Following is a brief description of those processes:

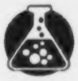
Basic Skills Icons and Enablers

To assist teachers and students in identifying activities that promote basic skills development, the CIMC has implemented a marking system that uses simple graphic symbols, or icons, and a list of specific tasks, or enablers, to identify the basic skill or skills that are called for in each job or assignment sheet.

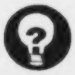
Each of the nine broad skills areas—reading, writing, mathematics, science, oral communication, interpersonal or relating, creative thinking and problem solving, employability, and social studies—is represented by the icon presented below.



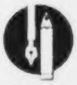
Reading



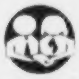
Science



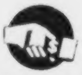
Creative Thinking/
Problem Solving



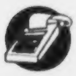
Writing



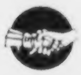
Oral Communication



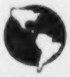
Employability



Math



Interpersonal or Relating



Social Studies

When an activity involving one of these basic skills is identified, the corresponding icon is placed in the left-hand margin of the job or assignment sheet. The basic skills training is further defined by retrieving the specific, or enabling, skill that is required by consulting a list of over two hundred and fifty enablers that has been compiled and grouped with each general basic skill. This enabling skill is placed directly below the icon.

As an example, an exercise that requires a student to conduct library research would make necessary the use of specific reading comprehension and research and reference skills. The basic skills that the exercise promotes would be depicted in the left-hand margin as follows:

ASSIGNMENT SHEET

PLANNING LIVING SPACE FOR HUMAN NEEDS

1

Name ______________________________ Score __________

OBJECTIVE 10

Define personal territory.

INSTRUCTIONS

Reading Comprehension
- Gain factual information

Functional Reading
- Follow written instructions
- Use content area vocabulary

Language
- Use standard grammar, spelling, and capitalization
- State ideas clearly

- As discussed in Objective 1, each person has an invisible "space bubble" or comfort zone. A comfort zone is the space between oneself and others that brings a feeling of well-being. When one's comfort zone is crowded or invaded, discomfort often results. Therefore, personal territory needs should be a prime consideration when planning living space.
- For each of the following situations, draw your estimated comfort zone around the figures provided.
- Indicate how many inches from your body the comfort zone extends.
- Consider how that comfort zone changes in different situations. Answer the questions that follow.

Basic Skills Documentation Matrix

Another component of the CIMC basic skills instructional plan is the "Basic Skills Documentation Matrix." The matrix graphically summarizes the basic skills training included in the vocational program, unit by unit. It should be helpful to teachers in planning their instruction, and to administrators as documentation that basic skills **are** being addressed during the vocational training.

The matrix for this publication is included as an 8½" by 11" foldout in this *Instructor's Manual.*

Matrices have been developed for most CIMC publications. For more information on those available for other programs, call the CIMC at 1-800-654-4502.

Instructional Supplement

The supplement is a tool for the instructor to use in helping students apply the basic skills in Assignment Sheets and Job Sheets. Some supplements are appropriate for use with all students; some are for use only with those students who do not understand the academic skills called for in the exercise.

MEASURING STUDENT PERFORMANCE GAINS

When you examine this book, you will notice that separate written pretests are no longer included in the units of instruction. Each CIMC unit now contains only a single Written Test. This test should be used as **both** pretest and posttest by giving it once before students start a unit and again when they have completed the unit.

The reason for using a single instrument as both pretest and posttest is so that direct comparison of each student's competencies before and after instruction can be made accurately. This comparison enables precise calculation, documentation, and evaluation of student **performance gains**.

Accurate performance gains analysis is an important requirement of the new Carl Perkins legislation for vocational education. Teachers can make an important contribution to the performance accountability mandated by the new federal legislation by carrying out accurate performance gains analysis for their students, and making this data available to students, parents, and administrators.

This analysis is easy to do and requires only simple calculations and record keeping. Detailed information regarding performance gains analysis is contained in the CIMC publication, *Measuring Learning & Competency Gains: The Pretest/Posttest Approach.* In addition, the CIMC has developed a computer program, CARL, which will perform all necessary calculations and will print out a record form of all information required for gain score analysis. Copies of CARL and the publication are available through your local testing liaison (in Oklahoma), or from the CIMC at 1-800-654-4502.

REQUIRED CRITERIA FOR A COMPETENCY-BASED EDUCATION PROGRAM

Criterion	Discussion	CIMC component meeting criterion
1. Instruction is based on clearly-stated learning objectives that are: a) observable and measurable, and b) communicated in writing to students before instruction begins.	Learning objectives drive CBE. Objectives are the "competencies" that learners must achieve. Each objective must clearly state what *learners* must *do* to demonstrate acquired skill or knowledge. Verbs in learning objectives are active and precise, stating the exact performance expected of learners. The objectives should also specify the standard or level of performance required. Objectives can be at any level of Bloom's Taxonomy and can include the cognitive, psychomotor, and affective domains. Higher-order cognitive skills should be included.	Objective Sheet
2. Instruction is aligned with the stated learning objectives	In CBE, the objectives specify what is taught. "Content" should relate to one or more objectives. The curriculum should cover all objectives with relevant information.	Information Sheet
3. There is a student evaluation system that is: a) criterion-referenced, and b) aligned to the learning objectives and the curriculum.	In CBE, the aim is to bring the performance of *all* learners up to a pre-defined standards and competencies. Learners work on each competency until they achieve "mastery"; the evaluation system should test and record this mastery. Learners can restudy and retest as often as needed. Specific remediation activities should also be available to learners when needed. The evaluation system focuses on what each student has achieved, not on what the instructor has "taught." The "constant" in CBE is student performance; the "variables" are time and resources. (This differs from traditional systems where learners get one chance at mastery; some succeed and some fail. In such systems, time and resources are constant and student achievement is variable.) If an evaluation is criterion-referenced, successful learner performance is defined by (or *referenced* to) mastery of pre-set objectives and standards (or *criteria*): there must be a careful match (or *alignment*) between what the student should master (objectives), what is taught (curriculum), and what is tested. Objectives, curriculum, and evaluation system must all match.	Written Test and Job Sheet/Skill Test

Criterion	Discussion	CIMC component meeting criterion
4. There is an observable management system of cognitive skill practice that provides for, promotes, and documents mastery learning.	For both cognitive and psychomotor skills, a CBE program must have a system of maintaining records of which skills and activities each learner has completed, which ones are in progress, and which ones have not yet been completed. Completion means "mastery"; no skill is completed until the learner has achieved the mastery level. The record system should promote feedback on student skill attainment to *both* instructor and learners, provide for remediation as needed, and encourage reevaluation of learner performance until mastery is achieved. Appropriate remediation strategies often should consider learning styles and other individual differences among learners. Learners should work on skills and activities until they achieve mastery. They should not be "passed on" without mastery. While learners may move ahead and work on other skills (i.e those for which all prerequisite skills have been mastered or those without prerequisites), work should also continue on the skills still requiring mastery. Students should not attempt higher-order skills until all prerequisite skills are mastered.	Assignment Sheet
5. There is an observable management system of psychomotor skill practice that provides for, promotes, and documents mastery learning.		Job Sheet/Skill Test
6. Skill mastery records are maintained for each learner, and learners have access to and make use of these records to monitor their skill acquisition.	Records should clearly indicate the skills each learner has mastered. One such record should profile or list the competencies that have been mastered and those to be mastered. Other performance indicators can be added and kept in a portfolio for each learner. Learners should have ready access to their portfolios to monitor their own progress in skill mastery and competency attainment.	Competency Profile

CORRECTIONS AND SUGGESTIONS

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This information will be used to correct the publication before the materials are reprinted. To ensure that the material is updated on a timely basis, notify the CIMC of necessary corrections as soon as possible after discovering the error.

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OBJECTIVE SHEET

HVAC MATERIALS

A 1

INTRODUCTION

This unit introduces you to the materials and components used in heating, ventilation, and air conditioning (HVAC) systems.

PREREQUISITE

Fundamentals of Construction

UNIT OBJECTIVE

After completing this unit, the student will be able to define terms and identify HVAC materials and components. The student will demonstrate these competencies by completing the assignment sheet and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to show the ability to:

1. Given a list of terms associated with HVAC materials, match them to their correct definitions.
2. Given a block diagram, match the major components of a HVAC system to their functions.
3. Select the correct application of piping types used in HVAC systems.
4. Given drawings, match pipe fittings to their names. (Assignment Sheet 1)
5. Match drawings of duct fittings to their correct titles and uses. (Assignment Sheet 2)
6. Match drawings of registers and diffusers to their titles. (Assignment Sheet 3)

SUGGESTED ACTIVITIES

HVAC MATERIALS

A 1

PREPARATION

- Review unit and plan presentation.
- Order or obtain materials to supplement unit.
- Introduce unit.

DELIVERY

Objective 1: Given a list of terms associated with HVAC materials, match them to their correct definitions.

- Use Information Sheet to discuss terms and definitions associated with HVAC materials.
- Show students examples or illustrations of appropriate terms.
- Point out the importance of knowing terms and definitions for common understanding.

Objective 2: Given a block diagram, match the major components of a HVAC system to their functions.

- Use Information Sheet to discuss the components of a typical HVAC system, a heat pump, and a heating unit.
- Use Transparencies 1-3.
- Obtain catalogs that illustrate any new technology available in the field of HVAC.
- Use the document, *Geothermal Heating and Cooling*, to explain geothermal concepts.

Objective 3: Select the correct application of piping types used in HVAC systems.

- Use Information Sheet to discuss types of tubing used in HVAC.
- Exhibit samples of the different types and sizes of tubing.

- Provide the class with plans specifying each type and size of tubing.
- Use Information Sheet to discuss applications for copper tubing, aluminum tubing, steel tubing, and neoprene flexible hose.
- Discuss applications for the different types of tubing. Discuss how some tubings can be used interchangeably while others must be used only for specific applications.
- Compare the use of rigid copper tubing to flexible copper tubing.
- Compare the applications of the different types of tubing such as steel, aluminum, and plastic.

APPLICATION

Objective 4: Given drawings, match pipe fittings to their name. (Assignment Sheet 1)

Objective 5: Match drawing od duct fittings to their correct title and use. (Assignment Sheet 2)

Objective 6: Match drawings of registers and diffusers to their titles. (Assignment Sheet 3)

- Allow students to practice the procedures in the assignment sheets.

EVALUATION

Pretest

- Give written test as pretest.
- Determine individual study requirements from pretest results.
- Counsel students individually on pretest results and study requirements.
- Modify materials in unit or create supplementary materials for individual students as required.

Skill Test

- Evaluate students on assignment sheet activities.
- Evaluate students on job sheet activities.
- Complete appropriate section of competency profiles.
- Reteach and reevaluate if necessary.
- Modify materials in unit or create supplementary materials for individual students as required.

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give the written test.

  NOTE: The written test may be given in sections if desired.

- Complete appropriate sections of competency profiles.
- Reteach and retest if necessary.
- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Print Media

- *Geothermal Heating and Cooling*, 1986. Oklahoma State University, 101 Industrial, Stillwater, OK. 74078

Electronic Media

- *Working Around High Voltage*, 1993. AGC of America, 1957 E. Street N.W., Washington, D.C. 20006.

UNIT REFERENCES

- Eckes, William and Dan Fulkerson. *Air Conditioning and Refrigeration Book III.* Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, Inc.
- Eckes, William and Dan Fulkerson. *Air Conditioning and Refrigeration Book IV.* Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, Inc.
- *Refrigeration and Air Conditioning*, ARI, 1501 Wilson Blvd., Arlington, VA. 22209.
- Wantiez, Gary W. *Air Conditioning and Refrigeration Fundamentals.* Stillwater, Oklahoma. Mid-America Vocational Curriculum Consortium, Inc.

INFORMATION SHEET — HVAC MATERIALS — A 1

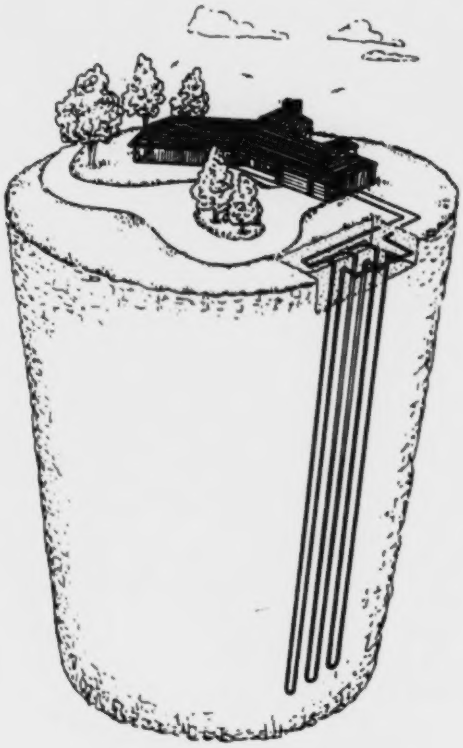
OBJECTIVE 1

Given a list of terms associated with HVAC materials, match them to their correct definitions.

- **accumulator** — a refrigerant storage tank in a heat pump
- **ACR copper** — type of tubing manufactured specifically for air conditioning and refrigeration that is free of contaminants and sealed; measured by outside diameter
- **air conditioning** — treatment of the air, including cooling, heating, humidifying, dehumidifying, filtering, and distribution
- **condense** — the moisture resulting from cooling vapor at the evaporator
- **evaporation** — the process of absorbing heat into a liquid and changing it to a vapor
- **flare** — enlarging the end of a piece of tubing to a 45-degree angle to allow a flared fitting can form a tight seal against it
- **flux** — mildly corrosive substance applied to a joint to prevent oxidation prior to soldering to prevent oxidation

- **geothermal heating and cooling** — a method of heating and cooling using the thermal energy absorbed by the earth (Figure 1)

FIGURE 1



NOTE: In the system shown, a water/anti-freeze solution is pumped into the earth's surface. The solution returns to help cool/heat the refrigerant in the heat pump.

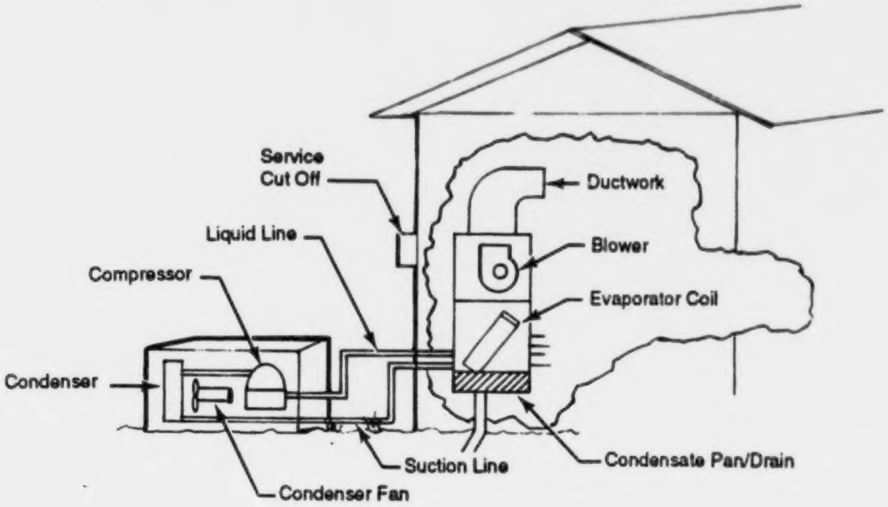
- **ground fault circuit interruption (GFCI)** — special circuits used to protect workers from electrical shock when using AC powered tools and equipment

- **heat pump** — a refrigeration machine that can pump heat in two directions; a reversing valve allows the same heat pump to cool in the summer or heat in the winter.
- **HVAC** — heating, ventilation, and air conditioning
- **hydronic** — system of heating or cooling that involves the transfer of heat by circulating fluid such as water or vapor in a closed system of pipes
- **nominal size copper** — type of tubing used on water lines, drains, and in other applications, but never in connection with refrigerants; measured by inside diameter
- **refrigerant** — the fluid used in a cooling system
- **soldering** — bonding two metals with a low-melting temperature metal
- **suction line** — the piping that returns vapor refrigerant to the compressor
- **swage** — enlarging one end of a piece of tubing so that the end of another tube of the same size will fit into it
- **sweating** — method of joining copper tubing to copper fittings by soldering

OBJECTIVE 2 **Given a block diagram, match the major components of a HVAC system to their functions.**

- Major components of a typical refrigeration cooling system (Figure 2)

FIGURE 2


Service Cut Off
Ductwork
Liquid Line
Blower
Compressor
Evaporator Coil
Condenser
Suction Line
Condensate Pan/Drain
Condenser Fan

— Outside of structure

a. Compressor — a pump that increases the pressure of refrigerant, causing it to cool and become a liquid

b. Condenser — a coil used to transfer heat away from the refrigerant

c. Condenser fan — a fan to blow away heat transferred to the condenser

d. Piping — the media used to transfer the refrigerant between the major components of a cooling system

Example: liquid and suction lines

— Inside of structure

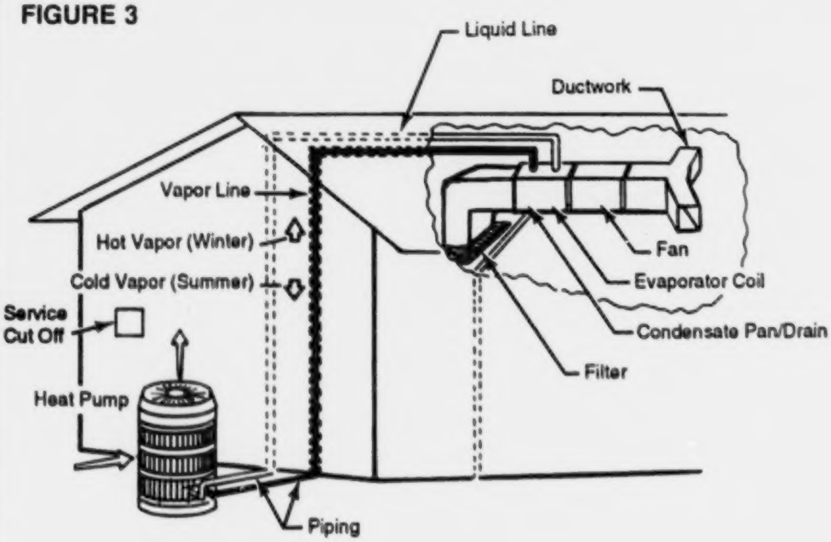
a. Evaporator coil — a coil that transfers heat into the refrigerant of a cooling system by evaporating the refrigerant

b. Blower — enhances the evaporation process by blowing or moving air over the evaporator coils and through the interior of the structure

c. Ductwork — sealed channels to convey air through the HVAC system and the interior of the structure

- Major components of a heat pump system (Figure 3)

FIGURE 3


Liquid Line
Ductwork
Vapor Line
Hot Vapor (Winter)
Cold Vapor (Summer)
Service Cut Off
Heat Pump
Fan
Evaporator Coil
Condensate Pan/Drain
Filter
Piping

— Outside structure

a. Heat pump — this unit contains the compressor, the condenser, the condenser fan, an accumulator, and a reversing valve to control the direction of the refrigerant

b. Piping — used to transfer the refrigerant between the components of the system

— Inside the structure

a. Evaporator coil — a coil that transfers heat into the refrigerant of a cooling system by evaporating the refrigerant

b. Blower — enhances the evaporation process by blowing or moving air over the evaporator coils and through the interior of the structure

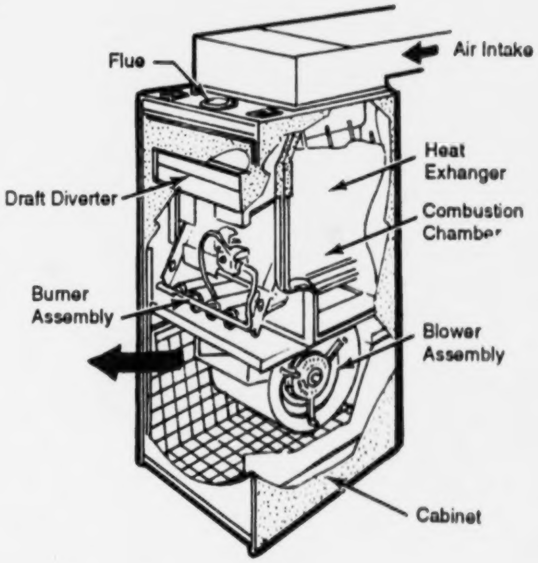
c. Ductwork — sealed channels to convey air through the cooling system and the interior of the structure

d. Condensate pan/drain — collects and drains moisture resulting from the evaporation process

NOTE: The geothermal heating and cooling system is becoming very popular as an energy-saving heating/cooling method.

- Major components of a gas-fired furnace (Figure 4)

FIGURE 4


Flue
Air Intake
Heat Exchanger
Draft Diverter
Combustion Chamber
Burner Assembly
Blower Assembly
Cabinet

- Flue — a duct that carries away exhaust fumes formed during gas combustion
- Draft diverter — a device that channels air to the flue to cause a constant updraft through the flue
- Heat exchanger — a device heated by the burner assembly; transfers heat to the air within the chamber
- Combustion chamber — the area where the gas is burned

OBJECTIVE 3 **Select the correct application of piping types used in HVAC systems.**

- Copper tubing
  - Color coding of copper tubing cartons and tags

    NOTE: The following type letters designate wall thicknesses; they are in descending order from heavy to thin wall.

    a. Green — Type K

    b. Blue — Type L

    c. Red — Type M

    d. Yellow — Type DWV

  - Most typical applications for copper tubing

    NOTE: Copper tubing sizes used in HVAC run from a diameter of ⅛ inch to over 6 inches, and they are hand drawn or tempered by annealing.

    1. Type M

       a. Underground water service

       b. Water distribution systems

       c. Chilled water systems

       d. Hot-water heating and low pressure steam

    2. Type L

       a. Underground water service where coils are permitted

       b. Hydronic heating system where coils are used

       c. Water heating or condensate return

3. Type K
    a. Wherever severe corrosion conditions exist
    b. Where self-support is vital
4. Type DWV
    a. Drain waste pipe
    b. Hot-water heating where pipe larger than 1¼ inch diameter is needed

— Applications for ACR copper tubing
  a. Suction line
  b. Liquid line
  c. Evaporator coils
  d. Condenser coils
  e. Discharge line

NOTE: Tubing for carrying refrigerant is available in "K," "L," and "M" wall thicknesses. The majority of the ACR tubing has "L" wall thickness.

- Applications for aluminum tubing
  1. Domestic refrigerators
      a. Evaporators
      b. Suction lines
  2. Central air conditioner condensers

- Applications for steel tubing
  1. Compression refrigeration
     a. Condensers
     b. Liquid lines
     c. Oil coolers

     NOTE: Steel lines are commonly used on domestic refrigeration.
  2. Absorption refrigeration — all refrigerant-carrying components must be steel tubing
- Applications for neoprene flexible refrigerant hose
  1. Central air conditioning where complicated bends might be required
  2. Units that have a tendency to vibrate excessively
- Application of black iron pipe
  1. Natural gas lines
  2. Liquified petroleum gas lines
  3. Ammonia lines
  4. Compressed air lines
  5. Hydronic heat and steam lines
- Application of galvanized iron pipe
  1. Water supply lines
  2. Water-cooled condenser supply and return lines
  3. Condensate lines and drains

- Application of PVC and flexible plastic pipe

  1. Flue venting

  2. Water supply lines

  3. Underground gas lines

  4. Condensate lines and drains

  5. Chilled-water supply and return lines

  NOTE: Check local codes before using plastic pipes.

- Application of PB or PE plastic pipe

  1. Condensate lines and drains

  2. Ground loops in geothermal heating and cooling applications

OBJECTIVE 4 **Given drawings, match pipe fittings to their names.** (Assignment Sheet 1)

- Copper tubing fittings

  — Flared fittings

  1. Seal cap

  2. Flare gasket

FIGURE 5

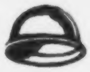
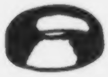


FIGURE 6



3. Cross

4. Union elbow

FIGURE 7

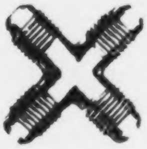
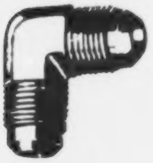


FIGURE 8



5. Female elbow

6. Reducing union elbow

FIGURE 9

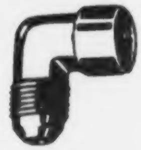
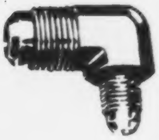


FIGURE 10



7. Long nut

8. Nut cap

FIGURE 11

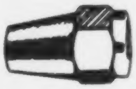
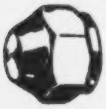


FIGURE 12



9. Flare cap

10. Plug

FIGURE 13

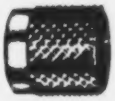
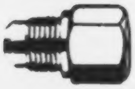
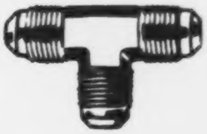


FIGURE 14



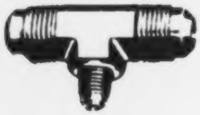
11. Union tee

FIGURE 15



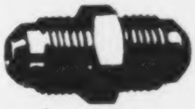
12. Reducing tee—large to small

FIGURE 16



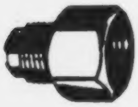
13. Union

FIGURE 17



14. Female connector

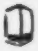
FIGURE 18



- Compression fittings

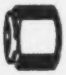
1. Sleeve (Ferrule)

FIGURE 19



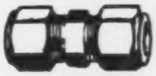
2. Nut

FIGURE 20



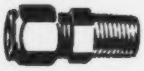
3. Union

FIGURE 21



4. Compression-to-pipe union

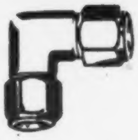
FIGURE 22



votech

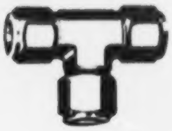
5. Union elbow

FIGURE 23



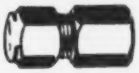
6. Union tee

FIGURE 24



7. Female connector

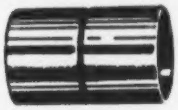
FIGURE 25



— Sweat fittings

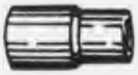
1. Coupling

FIGURE 26



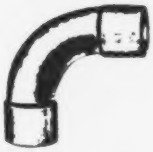
2. Coupling reducer

FIGURE 27



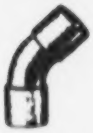
3. 90-degree elbow

FIGURE 28



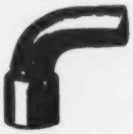
4. 45-degree elbow

FIGURE 29



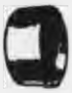
5. Street elbow

FIGURE 30



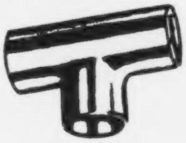
6. Cap

FIGURE 31



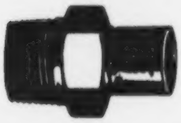
7. Tee

FIGURE 32



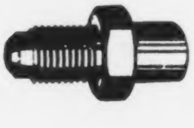
8. Sweat to pipe

FIGURE 33



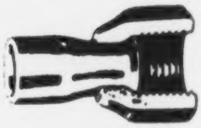
9. Sweat to flare

FIGURE 34



10. Sweat to flare swivel

FIGURE 35

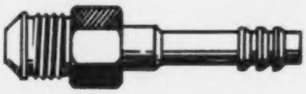


NOTE: Sweat-type elbows are available with a long or short bend radius.

- Flexible refrigerant hose and quick-connect fittings
  - Hose fittings

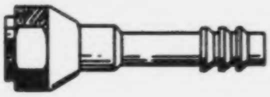
1. Male flare

FIGURE 36



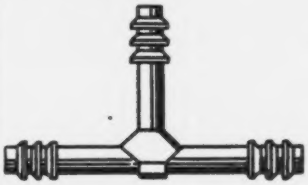
2. Female flare

FIGURE 37



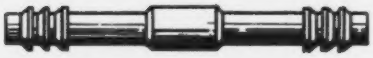
3. Tee splice

FIGURE 38



4. Straight splice

FIGURE 39



NOTE: Straight splice fittings are primarily used on automotive air conditioning.

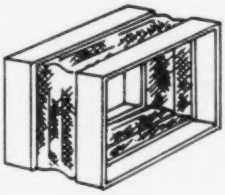
OBJECTIVE 4

Match drawing of duct fittings to their correct title and uses.
(Assignment Sheet 2)

- Commonly used HVAC duct fittings

  NOTE: Ducts and duct fittings are made from various types of materials such as galvanized steel, black steel, copper, stainless steel, aluminum transite, PVC, fibrous glass. Flexible ducts and duct fittings are made from a heavy canvas material. (Figure 61)

FIGURE 40



- Plenum (bonnet)

FIGURE 41

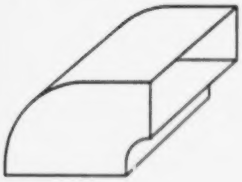


FIGURE 42

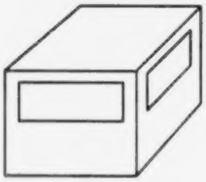
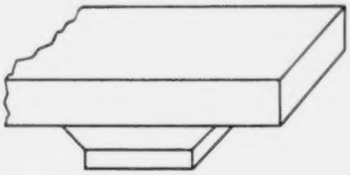


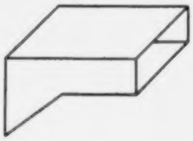
FIGURE 43



NOTE: The plenum is the first fitting from the air distribution system.

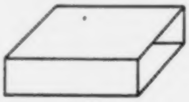
- Plenum takeoff

FIGURE 44



Straight transition

FIGURE 45

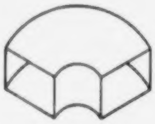


Straight rectangle

NOTE: Takeoff fittings are attached directly to the plenum and lead the air into the trunkline.

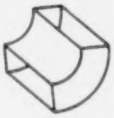
- Trunkline

FIGURE 46



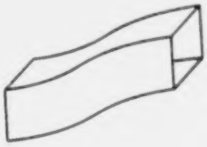
Square radius elbow

FIGURE 47



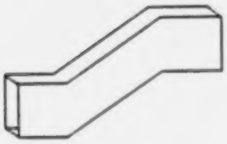
Rectangle radius elbow

FIGURE 48



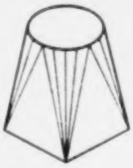
Offset (rolling)

FIGURE 49



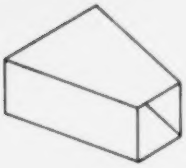
Offset (angler)

FIGURE 50



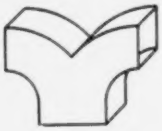
Square-to-round transition

FIGURE 51



Square-to-rectangle transition

FIGURE 52

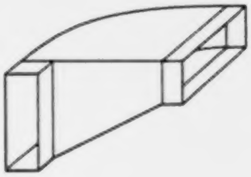


Y-branch

NOTE: Trunkline connects to the trunk takeoff which carries the air to the branches. Trunkline fittings can be round or rectangular and vary in size.

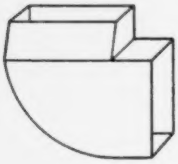
- Trunk duct takeoff

FIGURE 53



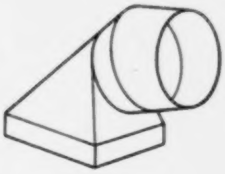
Side takeoff

FIGURE 54



Top takeoff

FIGURE 55

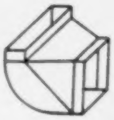


Square-to-round transition

NOTE: Trunk duct takeoffs are connected to the branch lines which carry the air to the boots. These fittings can be round or rectangular and or made as top or side takeoffs in various sizes.

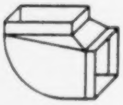
- Boots

FIGURE 56



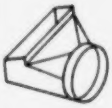
Square to wall

FIGURE 57



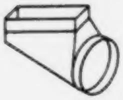
Square to floor

FIGURE 58



Round to wall

FIGURE 59

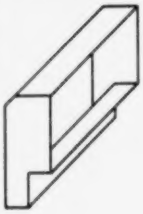


Round to floor

NOTE: Boot fittings direct the air flow from the branch line to the registers or to the stacks in the walls. These fittings can also be round to rectangular or square to rectangular and are available in various register sizes.

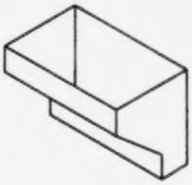
- Stackheads

FIGURE 60



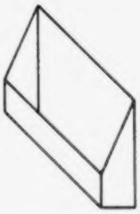
Wall

FIGURE 61



Floor

FIGURE 62



Baseboard

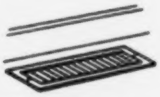
NOTE: These fittings lead the air from the stacks in the walls to the registers; these are available in various stack and register sizes.

OBJECTIVE 6 **Match drawings of registers and diffusers to their titles.** (Assignment Sheet 3)

- Common types of registers and diffusers

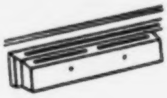
  — Floor register

FIGURE 63



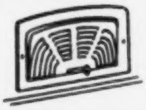
  — Baseboard register

FIGURE 64



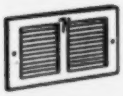
  — Low sidewall register

FIGURE 65



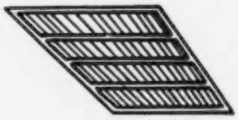
  — High sidewall register

FIGURE 66



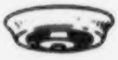
  — Ceiling panel

FIGURE 67



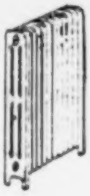
  — Ceiling diffuser

FIGURE 68



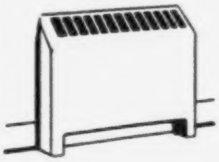
- — Cast iron radiator

FIGURE 69



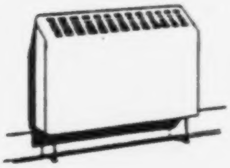
- Convection radiators

FIGURE 70



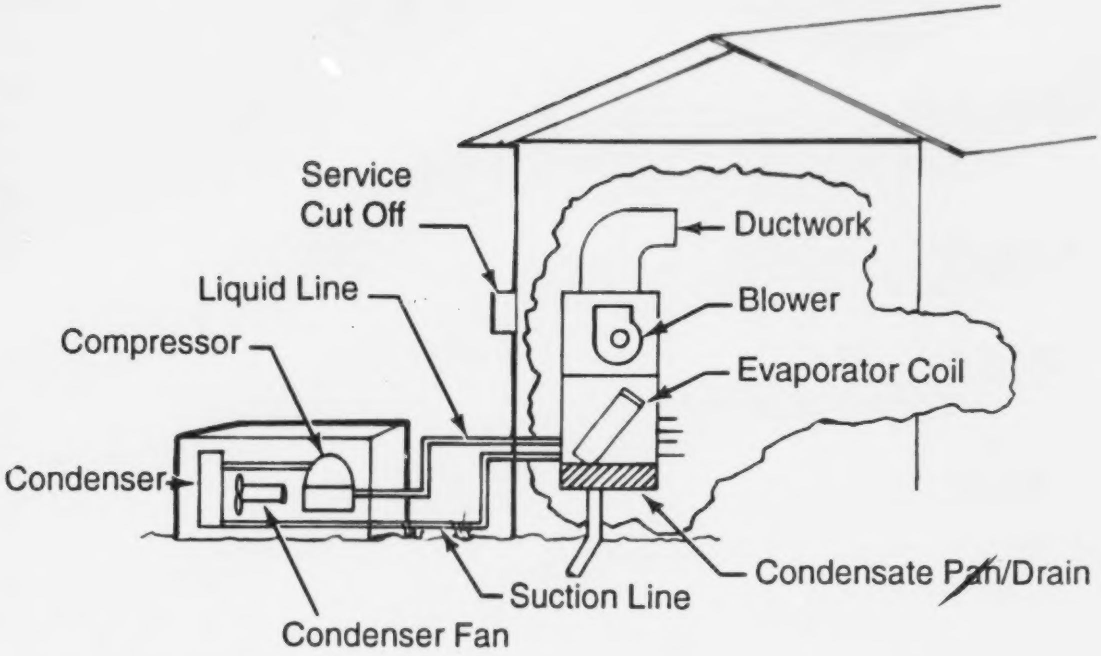
Standing

FIGURE 71

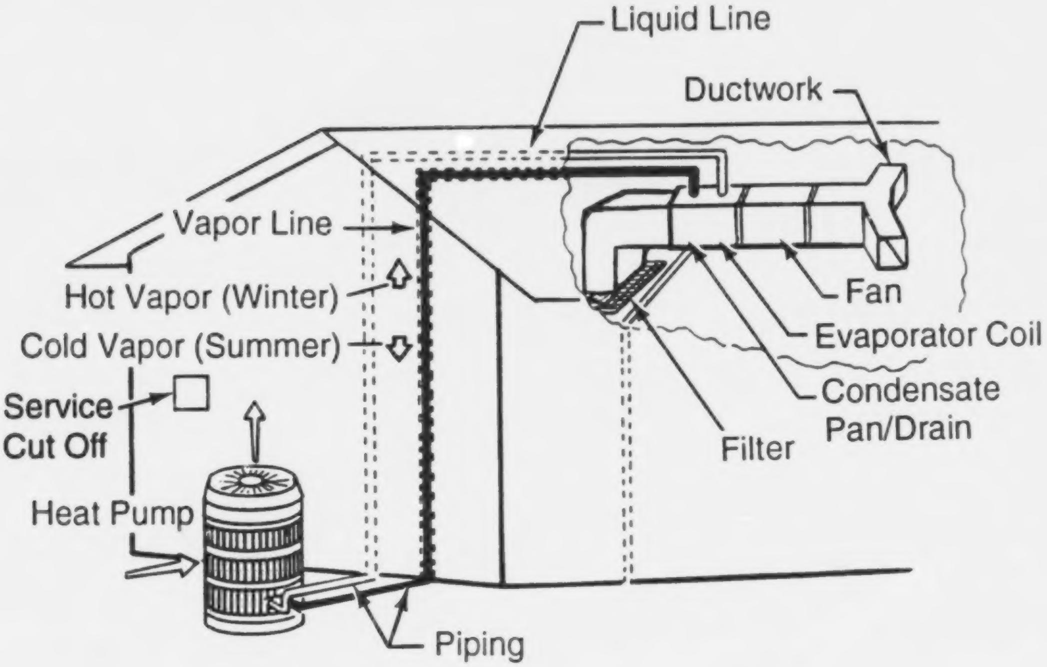


Wall hung

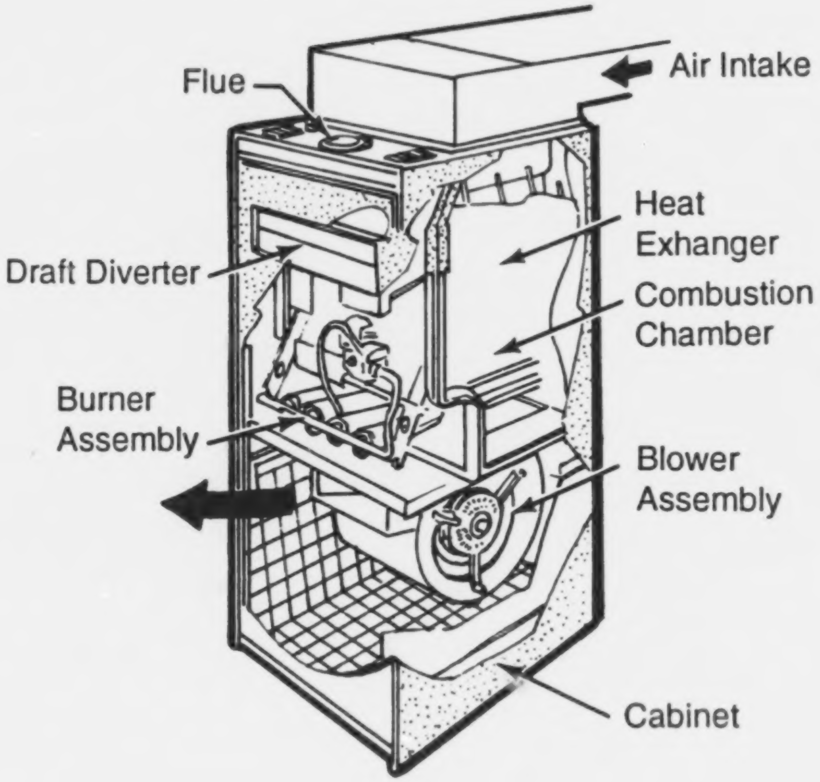
Air Conditioning System


Service
Cut Off
Liquid Line
Compressor
Condenser
Ductwork
Blower
Evaporator Coil
Condensate ~~Pan~~/Drain
Suction Line
Condenser Fan

Heat Pump System


Liquid Line
Ductwork
Vapor Line
Hot Vapor (Winter)
Cold Vapor (Summer)
Service Cut Off
Heat Pump
Fan
Evaporator Coil
Condensate Pan/Drain
Filter
Piping

Gas Fired Furnace


Flue
Air Intake
Heat Exhanger
Draft Diverter
Combustion Chamber
Burner Assembly
Blower Assembly
Cabinet

ASSIGNMENT SHEET 1

HVAC MATERIALS

A 1

Name ______________________ Score __________

OBJECTIVE 4

Given drawings, match pipe fittings to their names.

INTRODUCTION

There are many types of pipe fittings used in HVAC. Copper tubing is the most widely used. Practice identifying all types by completing this exercise.

INSTRUCTIONS

Identify fittings illustrated below. Write their correct names in the blanks.

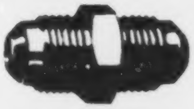
Functional Reading
- Use content area vocabulary

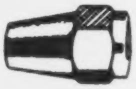
Part A - Flared fittings

Seal cap
Union elbow
Cap nut
Long nut
Flare gasket
Female elbow

Union tee
Reducing tee—
  large or small
Cross
Plug
Union

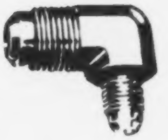
Female connector
Reducing union
  elbow
Flare cap

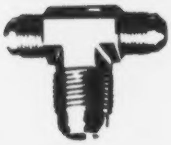




1. ____________________

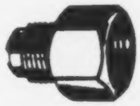
2. ____________________

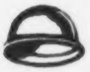




3. ______________________

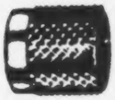
4. ______________________

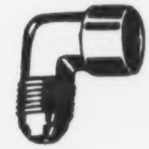




5. ______________________

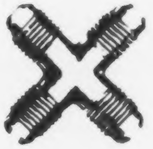
6. ______________________

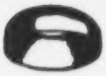




7. ______________________

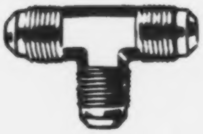
8. ______________________



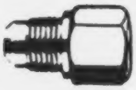


9. ______________________

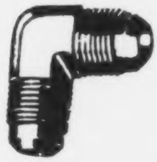
10. ______________________



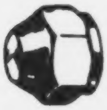
11. ____________________



12. ____________________



13. ____________________



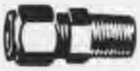
14. ____________________

Part B. Compression fittings

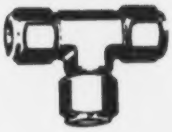
Union
Sleeve (Ferrule)
Female connector

Union tee
Nut
Union elbow

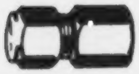
Compression to pipe union

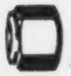


1. ____________________



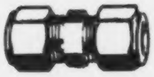
2. ____________________

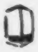




3. ____________________

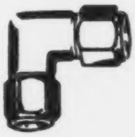
4. ____________________





5. ____________________

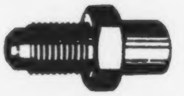
6. ____________________



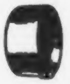
7. ____________________

Part C. Sweat fittings

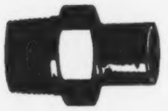
Sweat to flare
Sweat to flare swivel
45-degree elbow
Street elbow
90-degree elbow
Coupling reducer
Coupling
Sweat to pipe
Cap
Tee



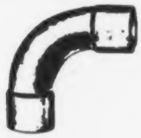
1. ______________________



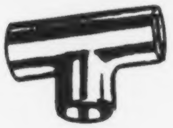
2. ______________________



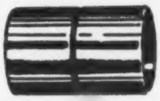
3. ______________________



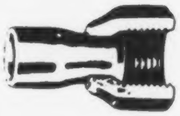
4. ______________________



5. ______________________



6. ______________________



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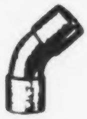
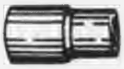
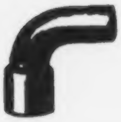


8. ______________________



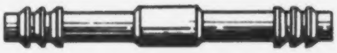


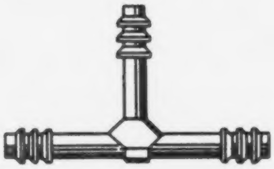
9. ______________________ 10. ______________________

Part D. Flexible refrigerant hose and disconnect fittings

Male flare	Straight splice
Tee splice	Female flare

A. Hose fittings





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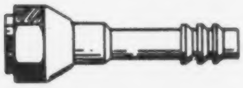
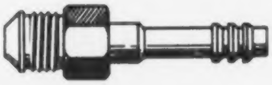




3. ______________________ 4. ______________________

63

ASSIGNMENT SHEET 2

HVAC MATERIALS

A 1

Name ______________________ Score ________

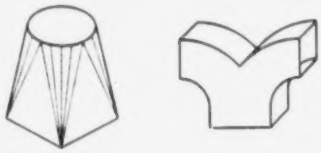
OBJECTIVE 5 **Match drawing of duct fittings to their correct titles and uses.**

INTRODUCTION This exercise will increase your ability to identify duct fittings by their shape and title.

INSTRUCTIONS Write the correct title of the duct below the drawing.

Plenum (bonnet)
Stackheads
Trunkline
Plenum takeoff
Trunk duct takeoff
Boots

Functional Reading
- Use content area vocabulary



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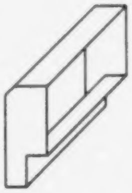

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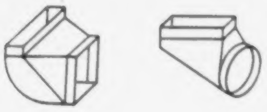

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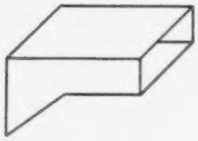

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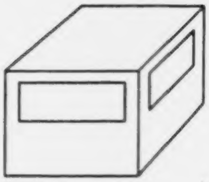
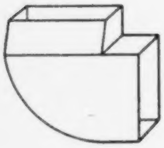




5. ______________________

6. ______________________

ASSIGNMENT SHEET 3

HVAC MATERIALS

A 1

Name ______________________________ Score __________

OBJECTIVE 6

Match drawing of registers and diffusers to their titles.

INTRODUCTION

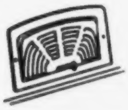
This exercise allows you to practice identifying registers and diffusers.

INSTRUCTIONS

Functional Reading
- Use content area vocabulary

Identify the name of each register and diffusers by writing the correct name below the drawing.

Baseboard register
Ceiling diffuser
Floor register
Convection radiator
High sidewall register
Low sidewall register
Ceiling panel
Cast iron radiator



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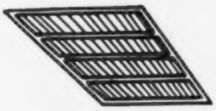
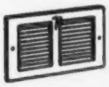


2. ____________________



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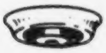

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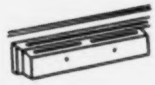
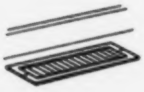
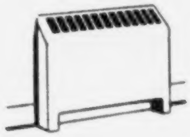
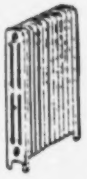




5. ______________________

6. ______________________





7. ______________________

8. ______________________

C7

ASSIGNMENT SHEET 1

Part A. Flared fittings

1. Union
2. Long nut
3. Reducing union elbow
4. Reducing tee—large to small
5. Female connector
6. Seal cap
7. Flare cap
8. Female elbow
9. Cross
10. Flare gasket
11. Union tee
12 Plug
13. Union elbow
14. Cap nut

Part B. Compression fittings

1. Compression-to-pipe union
2. Union tee
3. Female connector
4. Nut
5. Union
6. Sleeve (Ferrule)
7. Union elbow

Part C. Sweat fittings

1. Sweat to flare
2. Cap
3. Sweat to pipe
4. 90-degree elbow
5. Tee
6. Coupling
7. Sweat-to-flare swivel
8. 45-degree elbow
9. Coupling reducer
10. Street elbow

Part D. Hose fittings

1. Straight splice
2. Tee splice
3. Female flare
4. Male flare

ASSIGNMENT SHEET 2

1. Trunkline
2. Stackhead
3. Boots
4. Plenum takeoff
5. Plenum (bonnet)
6. Trunk duct takeoff

ASSIGNMENT SHEET 3

1. Low sidewall register
2. Ceiling panel
3. High sidewall register
4. Ceiling diffuser
5. Baseboard register
6. Floor register
7. Convection radiator
8. Cast-iron radiator

WRITTEN TEST

HVAC MATERIALS

A 1

Name ______________________________ Score __________

OBJECTIVE 1

Given a list of terms associated with HVAC materials, match them to their correct definitions. Write the letter that corresponds to the most correct answer.

_____ 1. The method of heating and cooling using the energy that has been absorbed by earth is called

a. hydronics
b. earth source heating/cooling
c. evaporative conditioning
d. geothermal heating/cooling

_____ 2. A method of joining copper tubing to copper fittings by soldering is called

a. bake joining
b. sweating
c. fluxing
d. welding

_____ 3. Special circuits used to protect workers from electrical shock when using AC powered tools and equipment is

a. GFCI
b. thermal circuits
c. ROI
d. circuit surgers

_____ 4. The piping that returns vapor refrigerant to the compressor is called a/an

a. liquid pipe
b. suction line
c. accumulator pipe
d. swage line

May be photocopied for student use.

_____ 5. The abbreviation "HVAC" is used for

a. High Voltage Alternating Current
b. Heating, Vents, and Air Conditioning
c. Heating, Ventilation, and Alternating Current
d. Heating, Ventilation, and Air Conditioning

_____ 6. A mildly corrosive substance applied to a joint to prevent oxidation prior to soldering is known as

a. sweat
b. hydro fluid
c. solder
d. flux

_____ 7. The enlarging of the end of a piece of tubing to a 45-degree angle so a flared fitting can form a tight seal is known as

a. sweating
b. fluxing
c. flaring
d. joint tapering

_____ 8. A refrigerant storage tank in a heat pump is called a/an

a. accumulator
b. condenser
c. vapor tank
d. evaporator

_____ 9. The fluid used in a cooling system is the

a. hydronic fluid
b. ACR liquid
c. refrigerant
d. anti-vapor

_____10. A type of tubing manufactured specifically for air conditioning and refrigeration systems is known as

a. swage pipe
b. ACR copper
c. compressor rated tubing
d. suction graded tubing

May be photocopied for student use.

_____11. The process of absorbing heat into a liquid and changing it to a vapor is called

a. evaporation
b. condensing
c. heat exchanger
d. thermal transfer

_____12. A refrigeration machine that can pump heat in two directions is called a

a. dual transfer unit
b. bi-coolant device
c. central compressor
d. heat pump

OBJECTIVE 2

Given a block diagram, match the major components of a HVAC system to their functions.

_____ 1. In a typical refrigeration cooling system, a pump that increases the pressure of the refrigerant is a

a. compressor
b. heat pump
c. blower
d. condenser

_____ 2. A fan that is used to blow away the heat from the outdoor coils is

a. condenser fan
b. blower
c. evaporator fan
d. duct fan

_____ 3. The fan that enhances the evaporation process and moves air through the interior of the structure is known as the

a. condenser
b. evaporator
c. duct fan
d. blower

May be photocopied for student use.

_____ 4. A coil that transfers heat into the refrigerant of a cooling system is a

a. compressor
b. condenser
c. evaporator
d. blower coil

_____ 5. A coil used to transfer heat away from the refrigerant is the

a. condenser
b. evaporator
c. compressor
d. blower coil

_____ 6. Sealed channels that convey air through a HVAC system are the

a. piping
b. ducts
c. flue
d. chamber

_____ 7. A component that has a reversing valve to control the direction of the refrigerant is known as a

a. compressor
b. condenser
c. evaporator
d. heat pump

_____ 8. A heat pump system component that collects and drains moisture is called a

a. drip pan/drain
b. evaporator
c. compressor
d. condensate pan/drain

May be photocopied for student use.

_____ 9. A duct that carries away exhaust fumes formed during gas combustion is a

a. diverter
b. exhaust chamber
c. flue
d. release pipe

_____10. A device that channels air to the flue and causes a constant updraft through the flue is a

a. flue duct
b. draft diverter
c. back chamber
d. heat exchanger

OBJECTIVE 3 **Select the correct application of piping types used in HVAC systems.**

_____ 1. Hydronic heating systems, where coils are used, require the use of

a. type L copper tubing
b. type K copper tubing
c. type DWV copper tubing
d. type M copper tubing

_____ 2. ACR copper tubing should be used in a cooling system as a

a. drain line
b. drip line
c. liquid line
d. heat exchanger line

_____ 3. Aluminum tubing would most likely be found in

a. liquid lines
b. compressors
c. below-ground drain lines
d. central air conditioner condenser coils

May be photocopied for student use.

_____ 4. Steel tubing would most likely be used in

a. refrigeration units
b. residential central air unit
c. condensate drain lines
d. evaporators

_____ 5. Galvanized iron pipe is used for which of the following applications?

a. Ammonia lines
b. LPG lines
c. Water-cooled condenser supply and return lines
d. Steam lines when used with radiator-type heating systems

_____ 6. PB and PE plastic pipe can be used as

a. ground loops in geothermal heating and cooling systems
b. evaporator of HVAC systems
c. condensers for central air conditioner systems
d. steam lines

_____ 7. What type of piping can be used in cooling systems for suction lines, evaporator coils, and liquid lines?

a. PVC plastic pipe
b. ACR copper tubing
c. Galvanized iron pipe
d. PB or PE plastic pipe

_____ 8. A common type of piping used in condensate drainage is

a. black iron pipe
b. steel tubing
c. aluminum tubing
d. PB or PE plastic pipe

May be photocopied for student use.

_____ 9. A red copper tubing carton or tag indicates tubing with a heavier wall than

a. yellow, type DWV
b. yellow, type M
c. green, type K
d. green, type L

_____10. Natural gas and ammonia lines would most likely be

a. galvanized iron pipe
b. black iron pipe
c. steel tubing
d. neoprene flexible refrigerant hose

May be photocopied for student use.

WRITTEN TEST ANSWERS

HVAC MATERIALS

A 1

OBJECTIVE 1	1. d	7. c
	2. b	8. a
	3. a	9. c
	4. b	10. b
	5. d	11. a
	6. d	12. d
OBJECTIVE 2	1. a	6. b
	2. a	7. d
	3. d	8. d
	4. c	9. c
	5. a	10. b
OBJECTIVE 3	1. a	6. a
	2. c	7. b
	3. d	8. d
	4. a	9. a
	5. c	10. b

OBJECTIVES 4-6 Evaluated through the use of assignment sheets.

Page 1 of 1

CIMC
TEST CODE SHEET

VOCATIONAL PROGRAM (BOOK TITLE) INTRODUCTION TO HVAC

UNIT NUMBER AND TITLE – A1 – HVAC MATERIALS

TOTAL NUMBER OF TEST QUESTIONS 32

TOTAL NUMBER OF BASIC SKILL QUESTIONS 2

OBJECTIVE NUMBER	TEST QUESTION NUMBER(S)	BASIC SKILL CODE(S)
1	**1, 11**	**S**
1	**2-10, 12**	**X**
2	**1-10**	**X**
3	**1-10**	**X**
4-6	**Evaluated on Assignment Sheets**	

OBJECTIVE SHEET

HVAC TOOLS AND EQUIPMENT

A 2

INTRODUCTION

This unit will introduce you to the tools and equipment used for the installation and testing of HVAC systems.

Other information includes the definition of basic terms and safety guidelines required of HVAC workers.

PREREQUISITE

Fundamentals of Construction

UNIT OBJECTIVE

After completing this unit, the student will be able to identify and safely use HVAC tools. The student will demonstrate these competencies by completing the assignment sheets and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student will be able to show the ability to:

1. Given a list of terms associated with HVAC tools and equipment, match them to their correct definitions.
2. Choose guidelines for the safe use and care of HVAC tools and equipment.
3. Given a drawing, match HVAC tools and equipment to their names. (Assignment Sheet 1)
4. Read a circumference rule. (Assignment Sheet 2)
5. Use inside and outside calipers. (Assignment Sheet 3)

votech

HVAC TOOLS AND EQUIPMENT

PREPARATION

- Review unit and plan presentation.
- Order or obtain materials to supplement unit.
- Give an overview of the course, explaining the organization of the materials from the basic terms to the use of HVAC equipment.
- Introduce unit.

DELIVERY

Objective 1: Given a list of terms associated with HVAC tools and equipment, match them to their correct definitions.

- Use Information Sheet to discuss terms and definitions associated with HVAC tools.
- Show examples or illustrations of appropriate terms.
- Explain the importance of knowing terms and definitions.

Objective 2: Choose guidelines for the safe use and care of HVAC tools and equipment.

- Show filmstrip/video, *Safety in Handling Refrigerants.*
- Discuss the hazards of electrical shock and procedures that can minimize the danger.

APPLICATION

Objective 3: Given a drawing, match HVAC tools and equipment to their proper names. (Assignment Sheet 1)

- Have students review tool catalogs; discuss the various tools, pointing out the importance of buying good grades of tools. Tell students that quality, not price, should be their main concern when purchasing tools.

Objective 4: Read a circumference rule. (Assignment Sheet 2)

Objective 5: Use inside and outside calipers. (Assignment Sheet 3)

EVALUATION

Pretest

- Given written test as pretest.
- Determine individual study requirements from pretest results.
- Counsel students individually on pretest results and study requirements.
- Modify materials in unit or create supplementary materials for individual students as required.

Skill Test

- Evaluate students on assignment sheet activities.
- Evaluate students on job sheet activities.
- Complete appropriate section of competency profiles.
- Reteach and reevaluate if necessary.
- Modify materials in unit or create supplementary materials for individual students as required.

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give the written test.

  NOTE: The written test may be given in sections if desired.

- Complete appropriate sections of competency profiles.
- Reteach and retest if necessary.

- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Electronic Media

- *Safety in Handling Refrigerants.* Slide/Cassette/Booklet. Available from DuPont de Numours and Co., Inc., Freon Products Division, Sales Support, Chestnut Run, Wilmington, Delaware, 1988.

UNIT REFERENCES

- Wantiez, Gary W. *Air Conditioning and Refrigeration Fundamentals.* Stillwater Oklahoma: Mid-America Vocational Curriculum Consortium, Inc., 1984.
- Zinngrabe, Claude J. *Sheet Metal Blueprint Reading for the Building Trades.* Albany, New York: Delmar Publishers, a division of Litton Educational Publishing, Inc., 1984.

OBJECTIVE 1

Given a list of terms associated with HVAC tools and equipment, match them to their correct definitions.

- **accessory** — object or device not essential in itself but adding to the beauty, convenience, or effectiveness of something else

- **ampere or amp** — unit of measure for the flow of electrical current

- **atmospheric pressure** — the weight of the atmosphere's gases measured in pounds per square inch (psi); measured with a barometer.

- **Btu (British thermal unit)** — the quantity of heat needed to increase the temperature of one pound of water by one degree fahrenheit

- **carbon monoxide** — a poisonous, odorless, and colorless gas that is produced by combustion

- **circumference rule** — rules used to find the circumference of a circle; cannot be used to measure directly

  NOTE: The circumference rule can measure the diameter and tell you the circumference; or if you know the circumference, it can tell you the diameter.

- **EPA (Environmental Protection Agency)** — agency of the federal government that regulates air and water quality; solid-waste management; and the control of toxic substances, pesticides, noise, and radiation to protect land, air, and water systems

  The EPA enforces laws that regulate the disposal of refrigerants and write reclaiming specifications. They are enpowered to levy huge fines for companies and/or persons not in compliance with regulations.

- **gage manifold** — a tool used to measure and adjust the quantity of refrigerant in a cooling system
- **ground fault circuit interruption (GFCI)** — special circuits used to protect workers from electrical shock when using AC powered tools and equipment
- **manometer** — a tool to test vapor pressures in a cooling system
- **ohm** — the unit of measure for electrical resistance
- **pipe reamer** — tool used to smooth the inside edges at the end of a piece of pipe by removing burrs and other rough places
- **pipe die** — device used to cut threads on the outside of pipe
- **thermometer** — a tool used to measure the level of heat (temperature)

  NOTE: In HVAC, thermometers are used to measure differences in temperature.
- **vacuum pump** — a tool used to remove air, moisture, and gases from a HVAC system
- **volt** — the unit of measure for the electrical difference between two points in a circuit

OBJECTIVE 2

Choose guidelines for the safe use and care of HVAC tools and equipment.

NOTE: These are only a few of the many safety rules and guidelines for workers using HVAC tools. Always follow OSHA regulations and consult with your instructor or supervisor when necessary.

- Guidelines for care and safe use of HVAC tools
  - Use the correct tool for the job being done.

- Keep tools clean, sharp, and in good condition.
- Inspect tools and accessories regularly.
- Repair broken or damaged tools promptly.
- Dispose of broken or damaged tools that cannot be repaired.
- Store tools properly.

  EXAMPLES: Do not carry tools in your pockets; do not place tools where they can roll off; protect cutting edges; lightly oil tools before storing; store tools in a dry place.

- Stay alert when using tools.
- Always wear eye protection.
- Wear appropriate clothing for job being performed.

- Guidelines for the safe use of equipment
  - Power tools
    1. Assume a safe and comfortable position before using a power tool.
    2. OSHA requires that GFCI circuits or other assured grounding system be used on all power tools and equipment.
    3. Keep a firm grip on the power tool while it is in use.
    4. Protect all testing equipment and instruments from shock and vibration.
    5. Report or correct any condition that may lead to an accident.
    6. Report any unusual noises, sounds, or vibrations to the instructor or supervisor.

7. Be sure that power tools are disconnected before performing maintenance or changing accessories.

— Test equipment

1. Treat refrigerants with care—they are stored under pressure. Wear goggles when transporting pressurized containers.

2. EPA regulations limit the amount of refrigerants allowed to escape to the atmosphere. Refer to your MSDS or manufacturer's instruction for details. The EPA also requires that personnel using refrigerants be certified.

3. Do not work around electricity when you, your tools, or the equipment are wet.

4. To avoid electrical shock, do not remove electrical access panels unless you have been properly trained.

5. Use only those tools that have insulated handles when working around electricity.

6. Whenever possible, work with de-energized electrical circuits.

7. Electrical shock occurs most often when workers are not alert to the dangers of electricity.

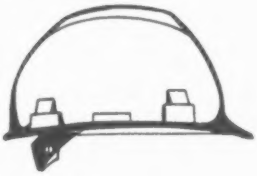
8. OSHA requires GFCI-protected circuits or an assured ground system be used when workers are using AC powered tools and equipment.

OBJECTIVE 2

Given a drawing, match HVAC tools and equipment to their proper names. (Assignment Sheet 1)

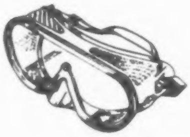
- Personal protection equipment
  - Hard hat

FIGURE 1



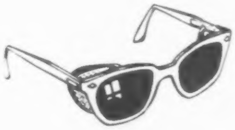
  - Goggles

FIGURE 2



  - Safety glasses

FIGURE 3



- Common hand tools
  - Measuring devices
    1. Rules
       - Folding rule
       - Steel tape

FIGURE 4

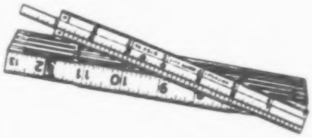
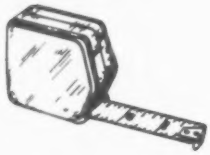


FIGURE 5



- 100-foot tape
- Combination square

FIGURE 6

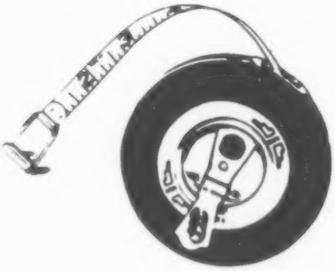
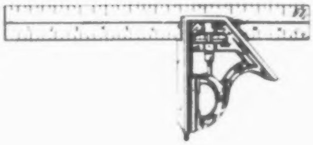


FIGURE 7



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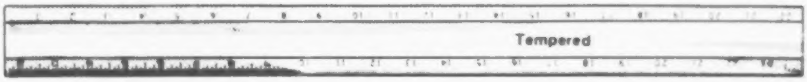
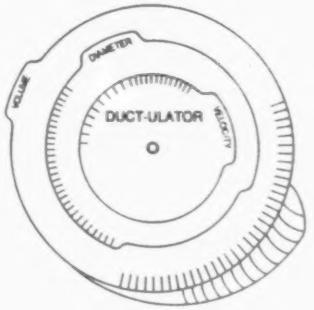
- Steel rule (bench rule)

FIGURE 8



- Duct-ulator

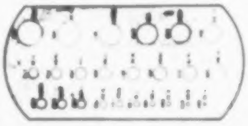
FIGURE 9


DIAMETER
VOLUME
DUCT-ULATOR
VELOCITY

2. Gauges

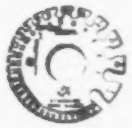
- Drill gauge

FIGURE 10



- Wire gauge

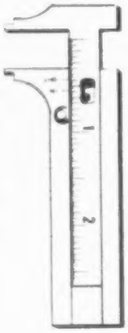
FIGURE 11



3. Calipers

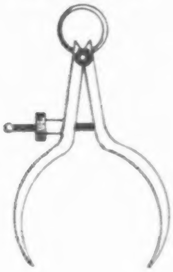
- Slide

FIGURE 12



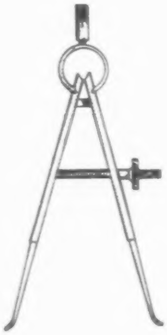
- Outside

FIGURE 13



- Inside

FIGURE 14



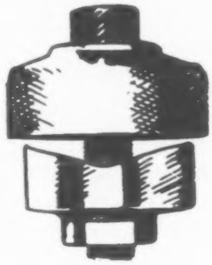
votech

- Miscellaneous hand tools

  1. Tools used to make holes

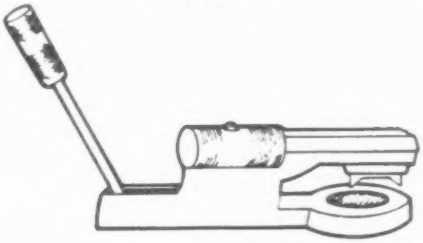
     — Knock-out cutter

FIGURE 15



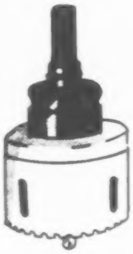
     — Hydraulic knock-out cutter

FIGURE 16



     — Hole saw

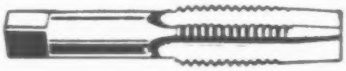
FIGURE 17



  2. Threading tools

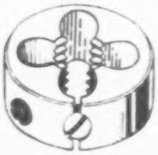
     — Tap

FIGURE 18



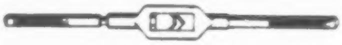
     — Die

FIGURE 19



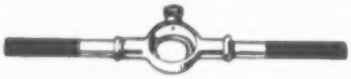
— Hand tap wrench

FIGURE 20



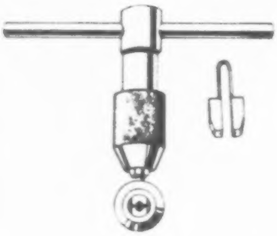
— Hand die wrench (die stock)

FIGURE 21



— T-handle tap wrench

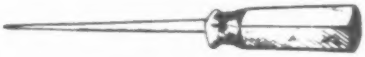
FIGURE 22



3. Marking tools

— Scratch awl

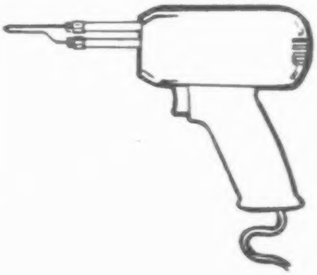
FIGURE 23



4. Soldering tool

— Soldering iron

FIGURE 24



- Specialty tools used in HVAC

  1. Tubing tools

     - Tubing cutter
     - Lever-type bender

FIGURE 25

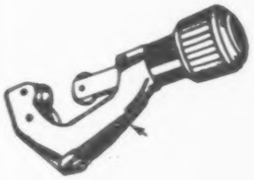
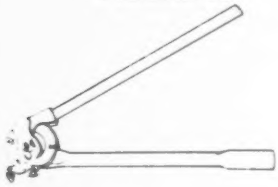


FIGURE 26



- Flaring tools and block
- Double-flare punches

FIGURE 27

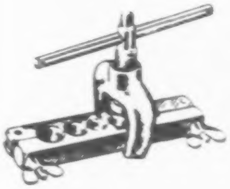
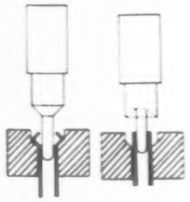
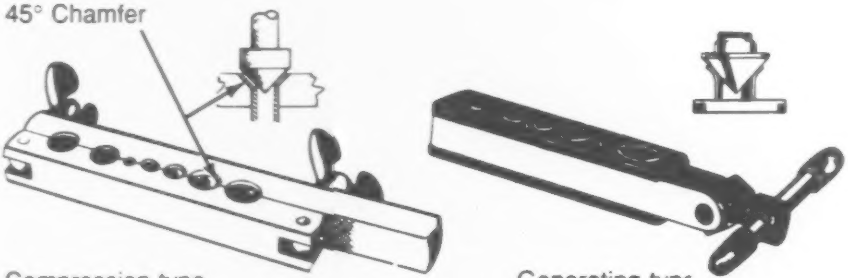


FIGURE 28



- Flaring blocks

FIGURE 29

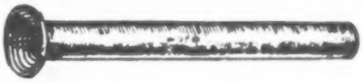


Compression type

Generating type

- Bending spring

FIGURE 30

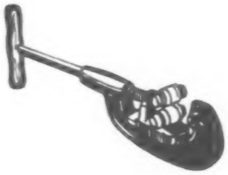


- Swage punch

FIGURE 31

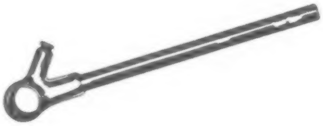
- Pipe cutting and threading tools
  - Pipe cutter

FIGURE 32



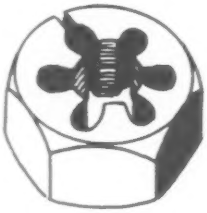
  - Die stock

FIGURE 33



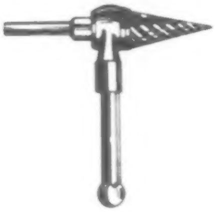
  - Pipe die

FIGURE 34



  - Pipe reamer

FIGURE 35



- Plastic pipe tools

  — PVC cutter

  — Utility knife

FIGURE 36

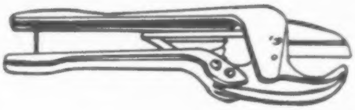
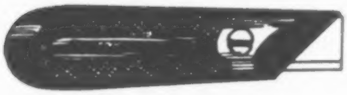


FIGURE 37



- Equipment used in HVAC

  1. Testing tools

     — Clamp-on ammeter

     — Volt-ohm meter

FIGURE 38

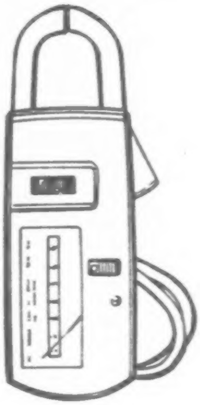
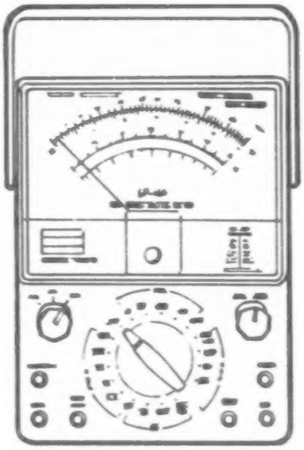


FIGURE 39



- Pocket thermometer
- Electronic thermometer

FIGURE 40

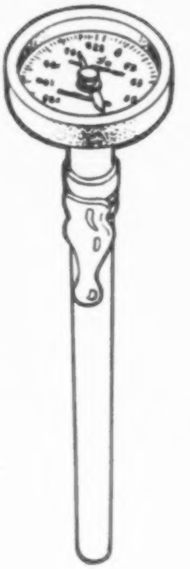
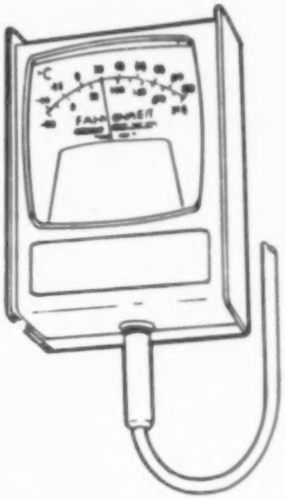
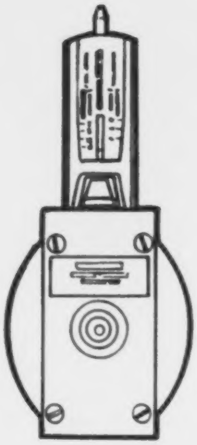


FIGURE 41



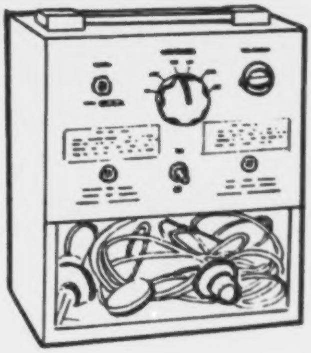
— Carbon monoxide indicator

FIGURE 42



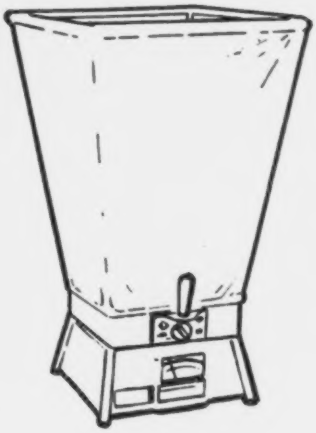
— Megometer (insulation tester)

FIGURE 43



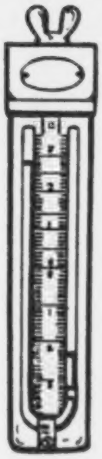
— Air balancing meter

FIGURE 44



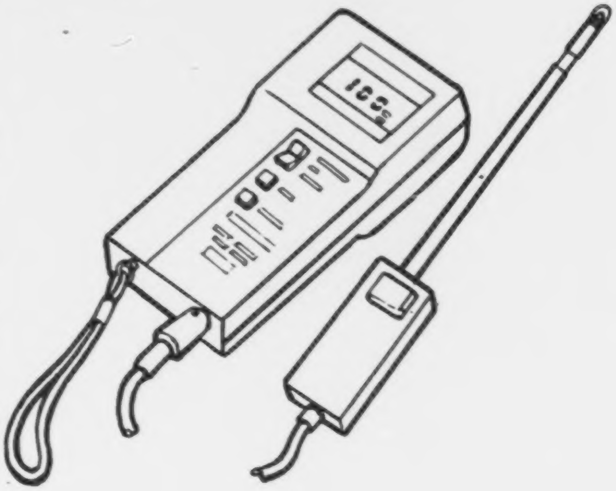
— Manometer

FIGURE 45



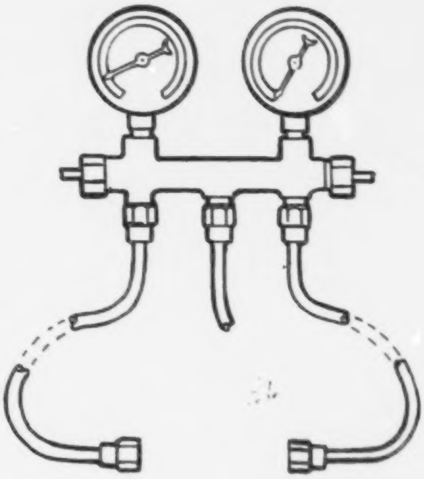
— Air velocity meter

FIGURE 46



— Gauge manifold

FIGURE 47



- Miscellaneous HVAC equipment
    - Charging station
    - Acetylene unit

FIGURE 48

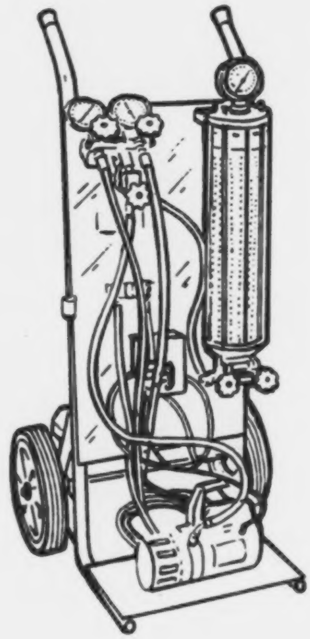
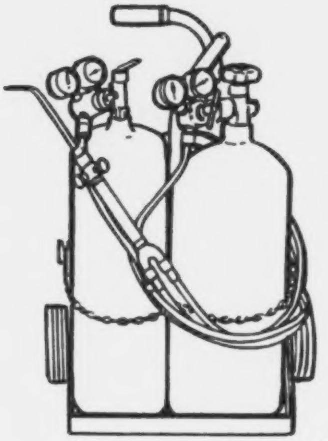
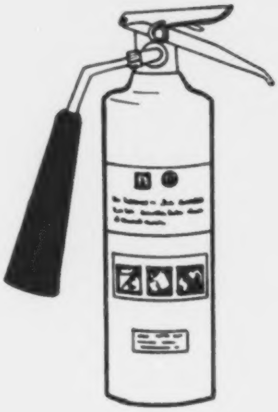


FIGURE 49



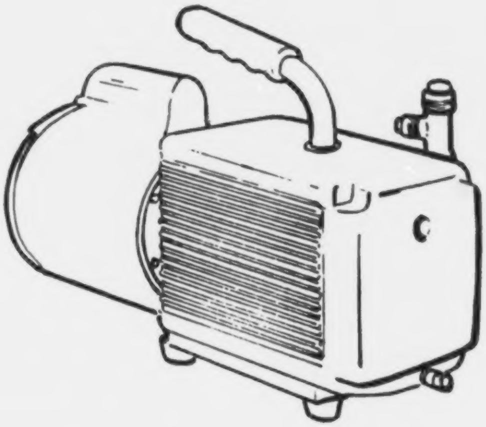
— Fire extinguisher

FIGURE 50



— Vacuum pump

FIGURE 51



- Power tools
  - Electric grinder
  - Reciprocating saw

FIGURE 52

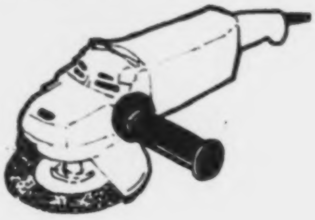
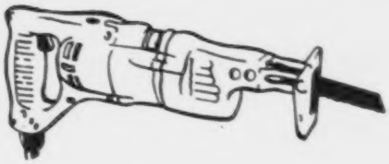
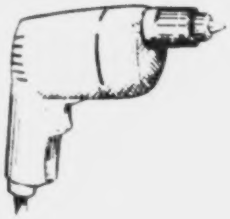


FIGURE 53



- Electric drill

FIGURE 54



ASSIGNMENT SHEET 1

HVAC TOOLS AND EQUIPMENT

A 2

Name ______________________________ Score ________

OBJECTIVE 3

Given a drawing, match HVAC tools and equipment to their names.

INTRODUCTION

There are many types of tools and equipment used in HVAC. This exercise allows you to practice the identification of common tools.

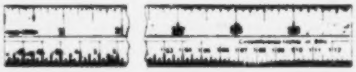
INSTRUCTIONS

Write the name of each tool or equipment below the appropriate drawing.

Functional Reading
- Use content area vocabulary

Part A — Hand tools

Steel tape
Circumference rule
Drill gauge
Wire gauge
Tap
Tube cutter
PVC cutter
Outside calipers
Inside calipers
Outside micrometer
Die
Hand die wrench
Flaring tool and block
Pipe cutter
Utility knife



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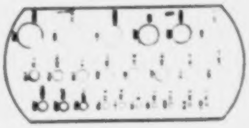
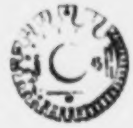
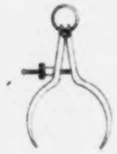
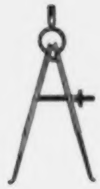




2. ______________________

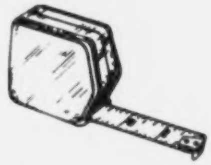
3. ______________________

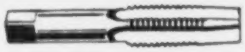




4. ______________________

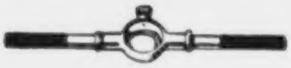
5. ______________________

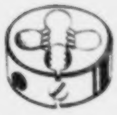




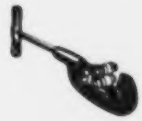
6. ______________________

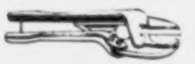
7. ______________________



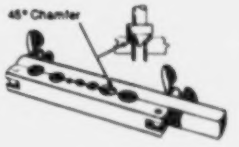


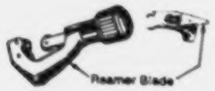
8. ____________________ 9. ____________________



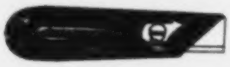


10. ____________________ 11. ____________________




Reamer Blade

12. ____________________ 13. ____________________

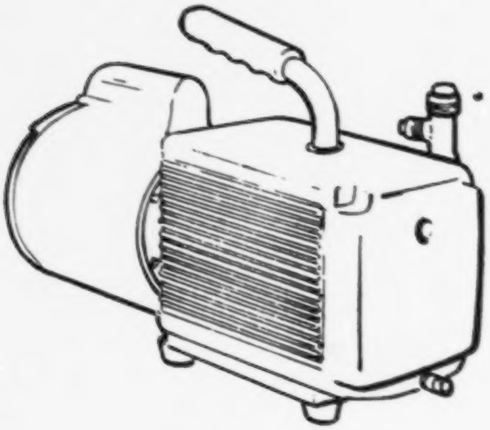


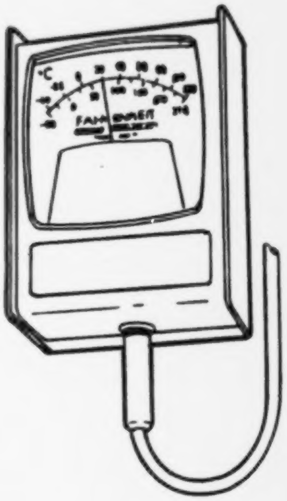
14. ____________________

Part B

Vacuum pump
Charging station
Gage manifold
Air balancing meter
Pocket thermometer

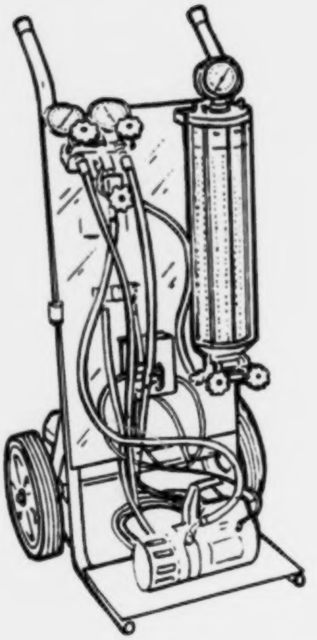
Carbon monoxide indicator
Manometer
Clamp-on ammeter
Volt-ohm meter
Electronic thermometer

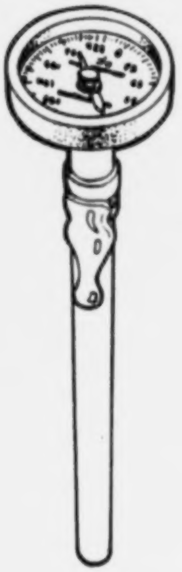




1. ____________________

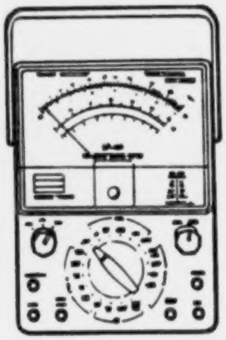
2. ____________________

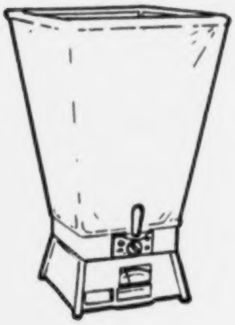




3. ____________________

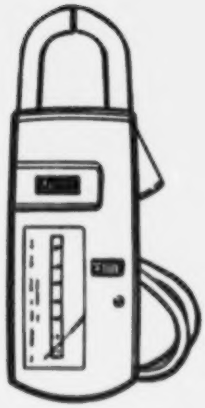
4. ____________________

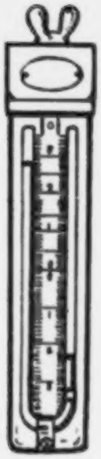




5. ____________________

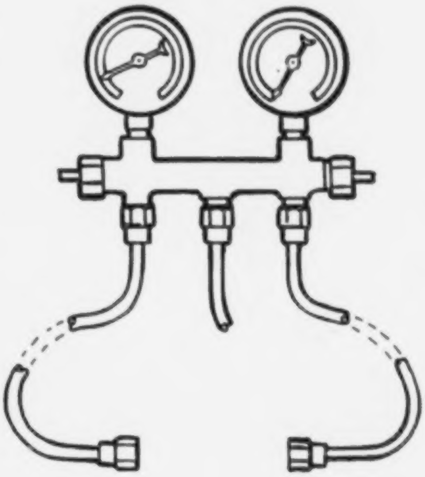
6. ____________________

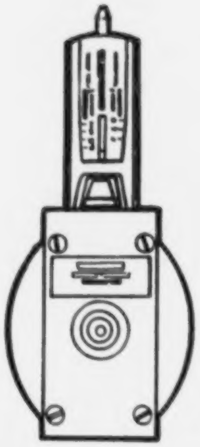




7. ______________________

8. ______________________





9. ______________________

10. ______________________

ASSIGNMENT SHEET 2

HVAC TOOLS AND EQUIPMENT

A 2

Name ______________________ Score ________

OBJECTIVE 4

Read a circumference rule.

INTRODUCTION

A circumference rule is designed to find the circumference of a circle when the diameter is known or find the diameter when the circumference is given.

INSTRUCTIONS

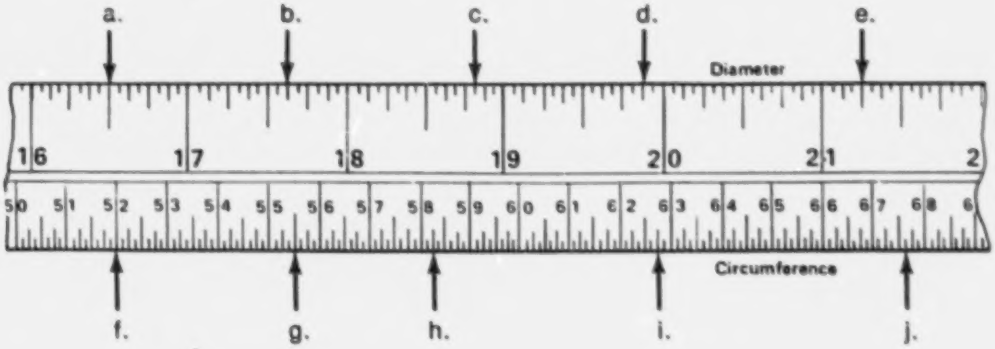
1. Practice by using the circumference rule shown below to find either the diameter or circumference of a circle. Read diameters to the closest 1/16" and circumferences to the closest 1/8".

Math Application

- Use English and metric measures

General Science

- Use scientific instruments


a.
b.
c.
d.
e.
Diameter
16
17
18
19
20
21
2
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
6
Circumference
f.
g.
h.
i.
j.

Given the diameter, find the circumference:

a. ______________________

b. ______________________

c. ______________________

d. ______________________

e. ______________________

Given the circumference, find the diameter:

f. ______________________

g. ______________________

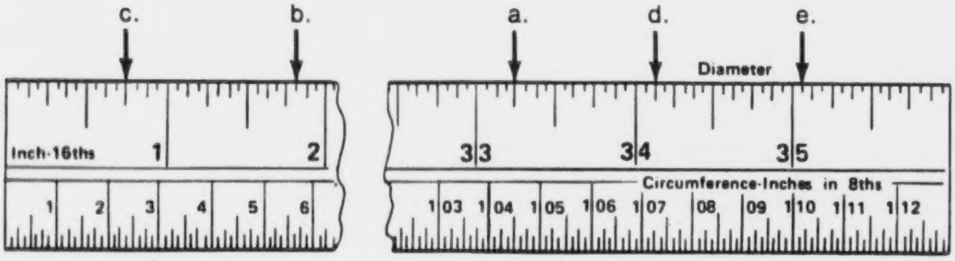
h. ______________________

i. ______________________

j. ______________________

2. Find the corresponding circumferences for each diameter below and write your answers in the blanks.

a. $33\frac{1}{4}$" dia.
b. $1\frac{13}{16}$" dia.
c. $\frac{3}{4}$" dia.
d. $34\frac{1}{8}$" dia.
e. $35\frac{1}{16}$" dia.


c.
b.
a.
d.
e.
Diameter
Inch-16ths
1
2
1
2
3
4
5
6
33
34
35
Circumference-Inches in 8ths
103
104
105
106
107
108
109
110
111
112

a. ______________________

b. ______________________

c. ______________________

d. ______________________

e. ______________________

CIMC
TEST CODE SHEET

VOCATIONAL PROGRAM (BOOK TITLE) INTRODUCTION TO HVAC

UNIT NUMBER AND TITLE – A2 – HVAC TOOLS AND EQUIPMENT

TOTAL NUMBER OF TEST QUESTIONS 20

TOTAL NUMBER OF BASIC SKILL QUESTIONS 6

OBJECTIVE NUMBER	TEST QUESTION NUMBER(S)	BASIC SKILL CODE(S)
1	**1, 2, 6, 9, 10, 11**	**S**
1	**3, 5, 7, 8, 12, 13**	**X**
2	**1-7**	**X**
3-6	**Evaluated on Assignment Sheets**	

OBJECTIVE SHEET

HVAC APPLIED SKILLS

A 3

INTRODUCTION

This unit introduces you to basic HVAC terms and provides practice exercises. Exercises include reading floor plans, calculating piping requirements, and preparing and joining various types of piping.

PREREQUISITE

Fundamentals of Construction

UNIT OBJECTIVE

After completing this unit, the student will be able to define basic HVAC terms and perform practical exercises. The student will demonstrate these competencies by completing the assignment sheets, job sheets, and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student will be able to show the ability to:

1. Given a list of terms associated with HVAC skills, match them to their correct definitions.
2. Identify types of supply duct systems.
3. Given alternatives, choose the major factors affecting HVAC duct system performance.
4. Name the methods used to measure piping used in an HVAC system.
5. Interpret HVAC symbols used on floor plans. (Assignment Sheet 1)
6. Given specifications, calculate the piping sizes required to install an HVAC system. (Assignment Sheet 2)
7. Cut, ream, and thread a specified length of steel pipe. (Job Sheet 1)

8. Make a flare with a compression-type flaring block. (Job Sheet 2)
9. Make a 90-degree bend in copper tubing. (Job Sheet 3)
10. Cut, ream, and join copper tubing using the sweat method. (Job Sheet 4)
11. Cut, ream, and join plastic pipe. (Job Sheet 5)

SUGGESTED ACTIVITIES

HVAC APPLIED SKILLS *A 3*

PREPARATION

- Review unit and plan presentation.
- Order or obtain materials to supplement unit.
- Introduce unit.

DELIVERY

Objective 1: Given a list of terms associated with HVAC skills, match them to their correct definitions.

- Use Information Sheet to discuss terms and definitions associated with HVAC layout and applied skills.
- Point out the importance of defining terms for common understanding and for better understanding of this unit.

Objective 2: Identify types of supply duct systems.

- Discuss the various types of duct systems, including why one system is used instead of another and advantages and disadvantages of each system.

Objective 3: Given alternatives, choose the major factors affecting HVAC duct system performance.

- Discuss the factors that affect the system design and the effects they have on the system performance.
- Discuss how heat is lost when extra-long ducts are used, and how heat loss occurs when a large number of offset fittings are used.
- Discuss heat loss in uninsulated ducts as compared to properly insulated ducts.
- Discuss information and procedures needed to lay out and size ductwork.

- Discuss what information is needed to select the proper registers and grilles for the supply and return air.

- Use Transparencies 1 and 2 to help reinforce your discussions.

- Discuss friction and how it affects the air distribution system and the duct design.

Objective 4: Name the methods used to measure piping used with in an HVAC system.

- Use the information sheet to discuss the methods to measure piping.

APPLICATIONS

Objective 5: Interpret HVAC symbols used on floor plans.

- Use the Information Sheet to discuss the symbols used in floor plans.

- Ask students to complete Assignment Sheet 1.

Objective 6: Given specifications, calculate the piping sizes required to install an HVAC system.

- Ask students to complete Assignment Sheet 2.

Objective 7: Cut, ream, and thread a specified length of steel pipe. (Job Sheet 1)

Objective 8: Make a flare with a compression-type flaring block. (Job Sheet 2)

Objective 9: Make a 90-degree bend in copper tubing. (Job Sheet 3)

Objective 10: Cut, ream, and join copper tubing using the sweat method. (Job Sheet 4)

Objective 11: Cut, ream, and join plastic pipe. (Job Sheet 5)

- Assign students to perform the steps outlined in Job Sheets 1-5.
- Show the video, *Electrical Safety*.

EVALUATION

Pretest

- Give written test as pretest.
- Determine individual study requirements from pretest results.
- Counsel students individually on pretest results and study requirements.
- Modify materials in unit or create supplementary materials for individual students as required.

Skill Test

- Evaluate students on assignment sheet activities.
- Evaluate students on job sheet activities.
- Complete appropriate section of competency profiles.
- Reteach and reevaluate if necessary.
- Modify materials in unit or create supplementary materials for individual students as required.

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give the written test.

  NOTE: The written test may be given in sections if desired.

- Complete appropriate sections of competency profiles.
- Reteach and retest if necessary.

- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Electronic Media

- *Electrical Safety*. Oklahoma Department of Vocational and Technical Education, 1500 W. Seventh Avenue, Stillwater, OK. 74074, (VHS, 29 min.)

UNIT REFERENCES

- Eckes, William and Dan Fulkerson. *Air Conditioning and Refrigeration book III*. Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, Inc.
- Toenjes, Leonard P. *Building Trades Dictionary*. American Technical Publishers, Inc.: Homewood, IL 60430.
- Whitman, William. *Refrigeration and Air Conditioning Technology*. 2 Computer Drive West, Albany, New York, 12212: Delmar Publishers.

OBJECTIVE 1

Given a list of terms associated with HVAC skills, match them to their correct definitions.

- **air velocity** — the speed of air movement measured in feet per minute (fpm) using an anemometer or air velocity meter
- **branch** — a duct connected to the main trunk of a forced-air system
- **cfm** — cubic feet per minute (volume)
- **condensation** — moisture produced when air is rapidly cooled
- **damper** — a device similar to a valve within the ductwork that maintains the desired airflow
- **effective length** — the actual length plus the equivalent length of ducts
- **equivalent length** — resistance to air flow created by the structural design of a fitting and indicated by the length of straight duct that would offer the same resistance
- **fpm** — feet per minute (velocity)
- **friction loss** — the reduction in air pressure in a duct system due to the type, size, and length of ductwork
- **plenum** — the first fitting of an air chamber off of an HVAC unit which receives the air from the blower and distributes it in the trunkline
- **refrigerant** — any substance that produces a refrigerating effect by its absorption of heat while evaporating
- **static pressure (sp)** — a measure of the resistance of ducts, grilles, filters, and other surfaces to the flow of air; this is the pressure inside ductwork, which is positive if the duct is a supply duct and negative if the duct is a return duct

- **system pressure** — sum of the negative and positive static pressures being exerted by a blower

- **takeoff** — the point of departure from a duct to which a duct fitting is attached for branching of ductwork

- **thermostat** — a device used to measure and control the air temperature in an area heated, ventilated, or cooled by an HVAC system

- **trunkline or trunk** — the main supply duct in a forced air system

- **warm-air heating system** — a combination of a furnace, ducts, and controls put together in such a way as to deliver warm air to all parts of a structure so that a comfortable living condition exists

- **zoning** — a method used to control air flow and temperature in specific areas or rooms; separate thermostats can be used to control a damper located within a branch duct.

OBJECTIVE 2 **Identify types of supply duct systems.**

- Types of supply duct systems
  - Radial or spider plenum
  - Trunk and branch reducing

FIGURE 1

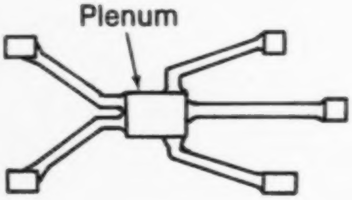
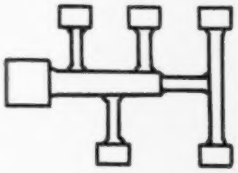
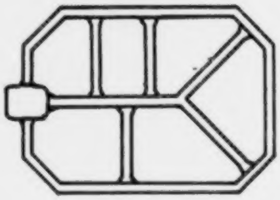


FIGURE 2



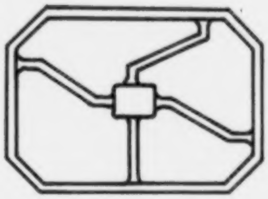
- Perimeter loop trunk duct

FIGURE 3



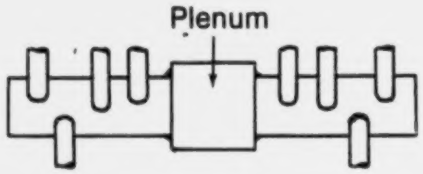
- Perimeter loop radial duct

FIGURE 4



- Trunk and branch extended plenum

FIGURE 5



OBJECTIVE 3

Given alternatives, choose the major factors affecting HVAC duct system performance.

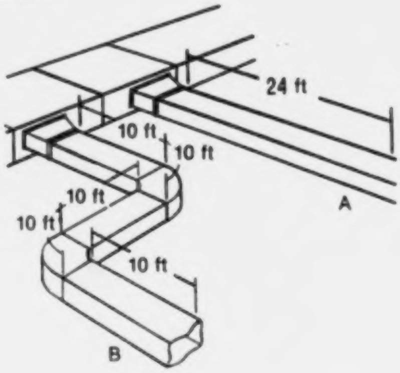
NOTE: HVAC system installers are given an HVAC floor plan and specifications that determine the type, size, and lengths of ductwork. An understanding of performance factors will improve your ability to install an HVAC system.

- There are four major factors that affect duct system performance.
  - Duct length
  - Duct diameter

  - Air flow
  - Duct wrap
- Duct length
  - Actual length — the physical length of a duct
  - Equivalent length — the size and shape of ducts and fittings will reduce the volume of air flow. The reduced air flow is due to an increase in resistance called flow friction. The equivalent length is given as a measure of this friction loss.

    EXAMPLE: The ducts in Figure 6 both extend 24′ from the trunkline. The curves in duct B add the equivalent of 10′ of air resistance. Due to the friction loss in the fittings of duct B, its equivalent length is 50′.

FIGURE 6



  - Effective length

    A. The effective length is used to determine the duct diameter for a specified system pressure.

    B. The effective length is computed by adding the actual length to the equivalent length.

— Duct diameter

A. Duct diameter is determined by the size required to maintain a specified system pressure.

B. Each outlet requires a specified air volume. This volume is also used to determine the branch duct diameter.

- Air flow

— Air flow in an HVAC system is produced by the fan or blower.

— Use Table 1 to select the desired air volume (CFM) in a given room. Then determine the required size of duct and outlet.

NOTE: The round ducts commonly used in residential applications are available commercially in sizes up to 10" in diameter. Larger ducts are available only in even inches of diameter. Rectangular ducts may be built to any size.

TABLE 1

ROUND DUCT DIAMETER	HIGH OR LOW WALL REGISTER	FLOOR DIFFUSER	ROUND CEILING DIFFUSER	RECOMM. MAXIMUM CFM
6"	10" × 6"	10" × 4"	6"	100—110 CFM
7"	12" × 6"	12" × 4"	7"	150—160 CFM
8"	14" × 6"	14" × 4"	8"	200—215 CFM

— Air filtering

A. Filters are installed in HVAC systems to remove dust, pollen, or other particles in the air.

B. Filters must be considered when calculating the air flow in ductwork.

C. When filters clog, they limit the efficiency of a HVAC system. With reduced air flow, the evaporator coils could freeze and equipment damage result.

D. Electrostatic filtering can be used to remove very small particles such as smoke and dust particles from the air. Such particles are electrically charged and passed through a filter charged with the opposite electrical charge. As a result, the filter traps the particles.

— Generally the air velocity (fpm) in the main trunkline is 1000 fpm and 500-750 fpm in a branch duct. For maximum comfort, these flow rates are recommended:

A. Floor diffusers — 450 fpm

B. Baseboard diffusers — 700 fpm

C. High sidewall registers — 350-500 fpm

D. Low sidewall registers — 500 fpm

NOTE: Inadequate velocity from any diffuser or register will cause uneven cooling or heating.

- Duct wrap

  — Insulation reduces the heat loss or heat gain in air passing through ducts. It also reduces or eliminates condensation.

  — Some ducts are pre-lined with insulation glued or fastened to the inside.

  — Fiberglass ducts have insulation built into them.

- Air quality

  — A significant factor in improving comfort and reducing static electricity is the humidifier.

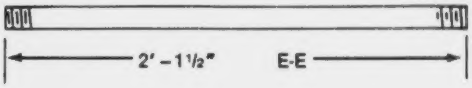
Humidifiers are used to increase the moisture content of air. They can be integrated into the HVAC system or be a stand-alone unit.

Humidifiers are becoming increasingly popular in facilities located in arid areas or in those in which interior heating systems excessively dry the air.

OBJECTIVE 4 **Name the methods used to measure piping in an HVAC system.**

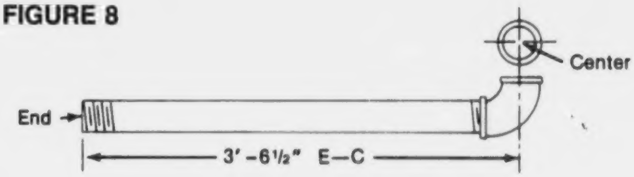
- Methods used to measure pipe
  - End to end
    - A. Straight length of pipe
    - B. Measure pipe without fittings

FIGURE 7



  - End to center
    - A. Straight length of pipe
    - B. Tighten a fitting on one end
    - C. Measure from end of pipe to center of fitting

FIGURE 8



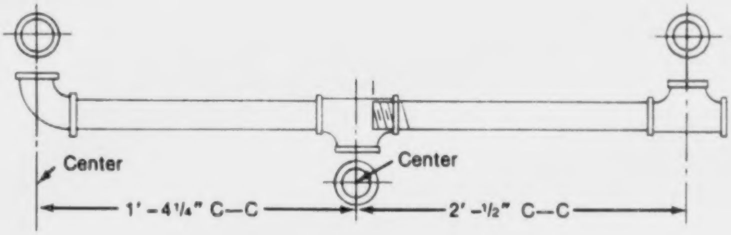
— Center to center

A. Straight length of pipe

B. Tighten fittings on each end

C. Measure from center of one fitting to center of the other fitting

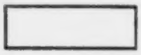
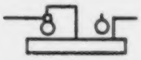
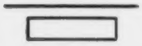
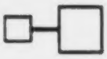
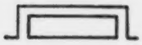
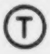
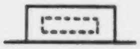
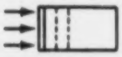
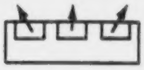
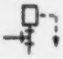
FIGURE 9



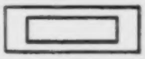
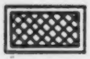
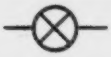
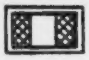
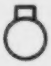
OBJECTIVE 5 **Interpret HVAC symbols used on floor plans.** (Assignment Sheet 1)

- HVAC symbols commonly used on plans

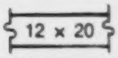
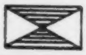
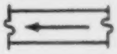
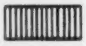
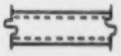
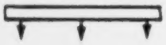
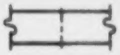
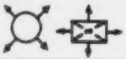
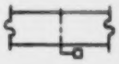
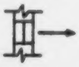
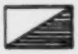
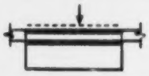
TABLE 2 Common HVAC symbols

Heating and Ventilating			
Heat transfer surface		Condenser	
Exposed radiator		Pump	
Recessed radiator		Thermostat	
Enclosed radiator flush		Intake louvers and screen	
Unit heater (centrifugal)		Automatic air vent	

Heating and Ventilating

Unit ventilation		Wall or space heater	
Thermostatic trap		Combination ceiling light, vent, and heater	
Compressor		Gas outlet	

Ductwork

Duct size		Supply duct section	
Direction of flow in duct		Floor register	
Lined ductwork		Linear diffuser	
Manual volume damper		Supply outlet, ceiling diffuser	
Automatic volume damper		Louver opening	
Exhaust, return or outside air duct section		Intake louvers on screen	

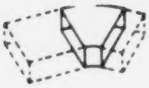
Heating pipes

Gas line, low pressure	— G — G —	Fuel oil return	— FOR —
Gas line, medium pressure	— MG —	Hot water heating supply	— HW —
Gas line, high pressure	— HG —	Hot water heating return	— HWR —
Fuel oil supply	— FOS —		

Duct Fittings and Equivalent Lengths

Angles and Elbows For Trunk Ducts

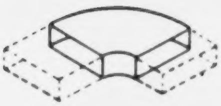
(Inside Radius = ½ Width of Duct)



Trunk Width Inches

A

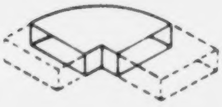
4 to 15 = 5 ft
16 to 27 = 10 ft
28 to 41 = 15 ft
42 to 52 = 20 ft
53 to 63 = 25 ft



Trunk Width Inches

B

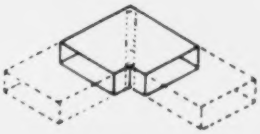
4 to 11 = 10 ft
12 to 21 = 15 ft
22 to 27 = 20 ft
28 to 33 = 25 ft
34 to 42 = 30 ft
43 to 51 = 40 ft
52 to 64 = 50 ft



Trunk Width Inches

C

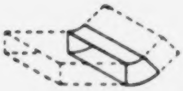
4 to 6 = 20 ft
7 to 11 = 40 ft
12 to 15 = 55 ft
16 to 21 = 75 ft
22 to 27 = 100 ft
28 to 33 = 125 ft
34 to 42 = 150 ft



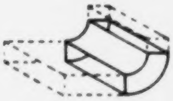
Trunk Width Inches

D

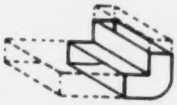
4 to 11 = 15 ft
12 to 21 = 20 ft
22 to 27 = 25 ft
28 to 42 = 40 ft



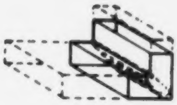
E=5 ft



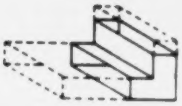
F=10 ft



G=30 ft



H=15 ft

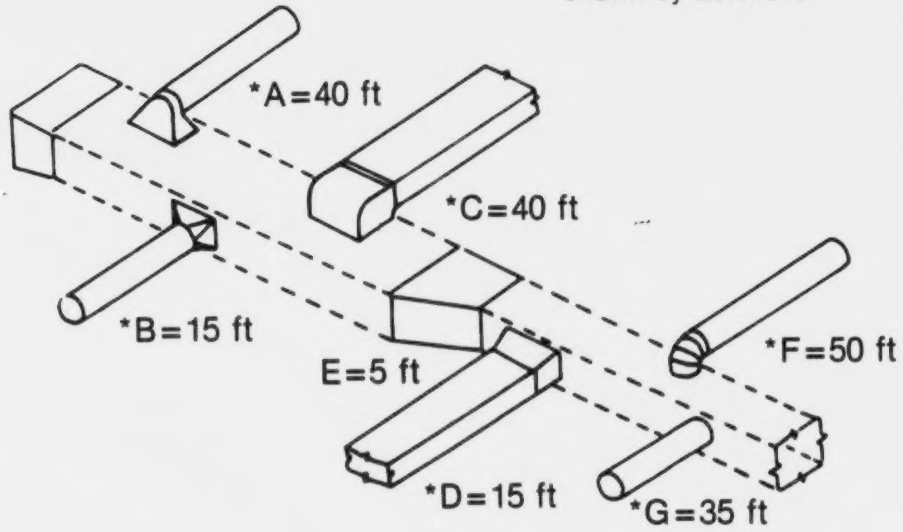


I=30 ft

Duct Fittings and Equivalent Lengths

Extended Plenum Fittings

Add 25 equiv. feet to each of the 3 fittings nearest the unit in each trunk duct and after each reduction as shown by asterisks.


*A=40 ft
*C=40 ft
*B=15 ft
*F=50 ft
E=5 ft
*D=15 ft
*G=35 ft

Drawings of various fittings with equivalent lengths shown

ASSIGNMENT SHEET 1 HVAC APPLIED SKILLS A 3

Name ______________________ Score ________

OBJECTIVE 5 **Interpret HVAC symbols used on floor plans.**

INTRODUCTION Practice interpreting HVAC symbols by answering the questions and identifying the symbols.

INSTRUCTIONS Use the floor plan to answer the questions below.

Functional Reading
- Interpret graphics and symbols
- Use content area vocabulary

Data Analysis and Display
- Interpret plans/blueprints

Part A

1. What type of duct system is shown in the floor plan?

   ____

2. The thermostat is to be installed in which room?

   ____

3. What type of duct outlets are specified by the floor plan?

   ____

4. Where is the return air duct located?

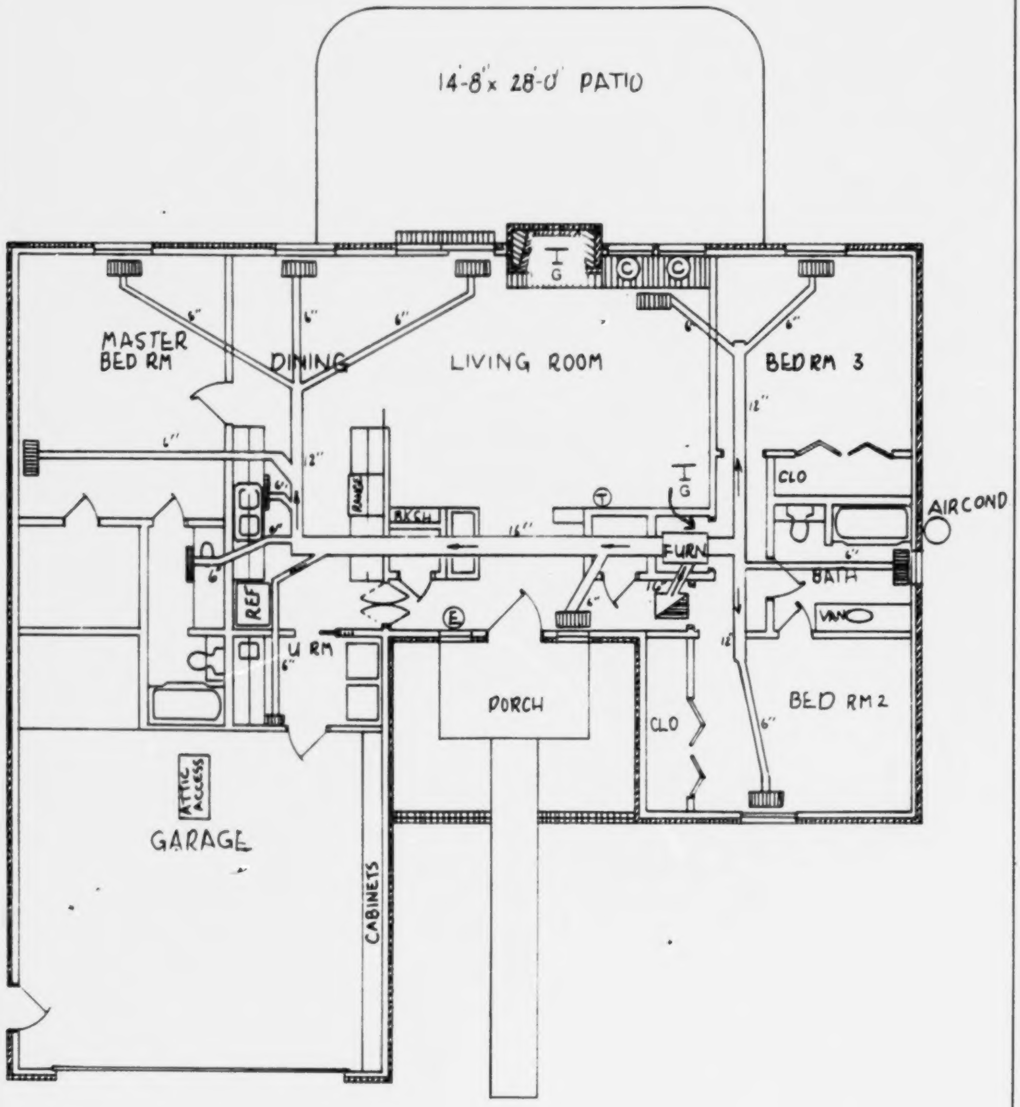
   ____

5. How many gas outlets are required in the plan?

   ____

6. How many duct outlets are in the living room?

   ____


14'-8" x 28'-0" PATIO
MASTER BED RM
DINING
LIVING ROOM
BED RM 3
6"
6"
6"
6"
6"
6"
12"
12"
16"
6"
G
G
T
C
C
RANGE
REF
E
FURN
AIR COND
CLO
BATH
VAN
U RM
PORCH
CLO
BED RM 2
12"
6"
ATTIC ACCESS
GARAGE
CABINETS

HVAC FLOOR PLAN

SCALE:-1/8"=1'-0"

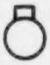
N

Part B

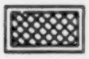
INSTRUCTIONS

Identify the following HVAC symbols used on plans. Write the correct names in the blanks.

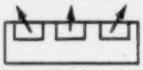
a. Heating and ventilating



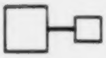
1. ____________________



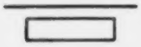
2. ____________________



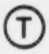
3. ____________________



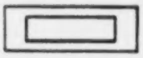
4. ____________________



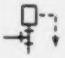
5. ____________________



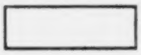
6. ____________________



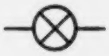
7. ____________________



8. ____________________

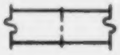


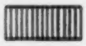
9. ____________________

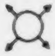


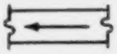
10. ____________________

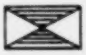
b. Ductwork

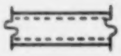

11. ______________________________

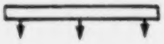

12. ______________________________

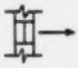

13. ______________________________


14. ______________________________


15. ______________________________


16. ______________________________


17. ______________________________


18. ______________________________

c. Heating pipes

— FOR — 19. ______________________________

— HG — 20. ______________________________

— HWR — 21. ______________________________

— G — G — 22. ______________________________

ASSIGNMENT SHEET 2

HVAC APPLIED SKILLS

A 3

Name ______________________ Score __________

OBJECTIVE 6

Given specifications, calculate the piping sizes required to install an HVAC system.

INTRODUCTION

Use the knowledge and skills you've gained to analyze and determine the material required to install a gas furnace.

EQUIPMENT AND SUPPLIES

- Ruler
- Unit A 1 of this document

INSTRUCTIONS

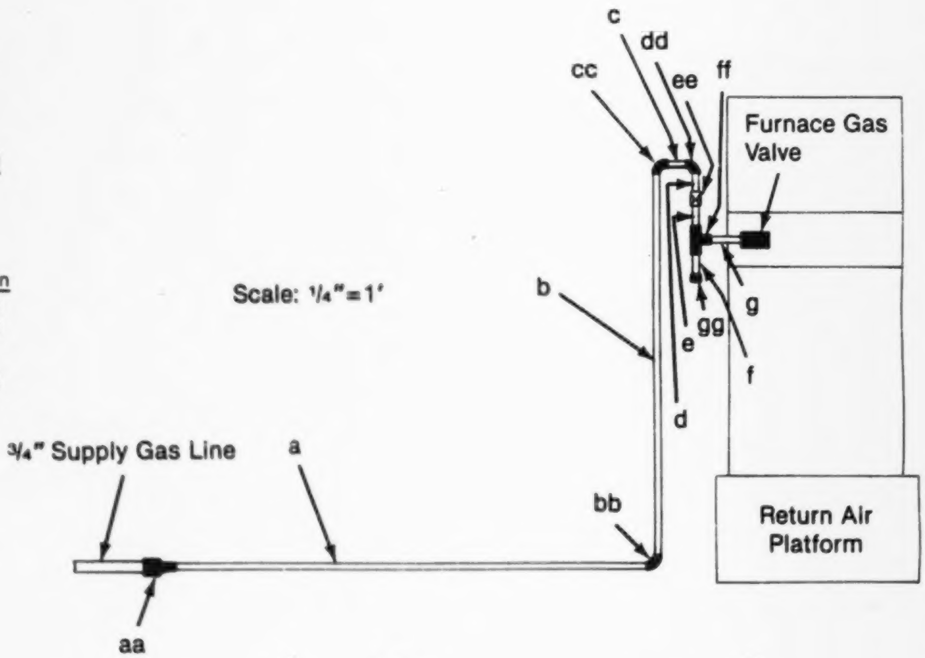
Make a list of the pipe length and the fittings necessary to connect the gas furnace below to the supply gas line. Place a gas cock in the line prior to where the line enters the furnace cabinet. Gas valve has ½" female pipe inlet. Single letters are used to represent pipe lengths and double letters represent the fittings sizes.

Functional Reading
- Interpret graphics and symbols

Operation and Calculation
- Calculate with fractions

Math Application
- Use English and metric measures

Data Analysis and Display
- Interpret plans/ blueprints



Functional Math
- Make measurements

Pipe length	Size/fitting
a. ______	aa. ______
b. ______	bb. ______
c. ______	cc. ______
d. ______	dd. ______
	ee. ______
	ff. ______

ASSIGNMENT SHEET 1

Part A

1. Radial or spider
2. Living room
3. Floor register
4. Hallway
5. Two-gas fireplace, furnace
6. Two

Part B

1. Compressor
2. Wall or space heater
3. Unit heater
4. Pump
5. Exposed radiator
6. Thermostat
7. Unit ventilation
8. Automatic air vent
9. Heat transfer surface
10. Thermostatic trap
11. Manual volume damper
12. Floor register
13. Supply outlet—ceiling diffuser
14. Direction of air
15. Supply duct
16. Lined ductwork
17. Linear diffuser
18. Louver opening
19. Fuel oil return
20. Gas line—high pressure
21. Hot water heating return
22. Gas line—low pressure

ASSIGNMENT SHEET 2

a. 12′-0″
b. 9′6″
c. 1′
d. 1′
aa. ¾″ to ½″ reducer
bb. ½″ ell
cc. ½″ ell
dd. ½″ ell
ee. ½″ union
ff. ½″ tee

OBJECTIVE 7 **Cut, ream, and thread a specified length of steel pipe.**

INTRODUCTION

This exercise will allow you to practice in measuring, marking, cutting, and reaming steel pipe.

TOOLS AND EQUIPMENT

- Hard hat and goggles
- Folding rule
- Pencil
- Piece of ½" steel pipe
- Drip pan
- Pipe die/ratchet
- Pipe vise
- Wire brush
- Oil
- Shop towel
- Pipe cutter
- Reamer

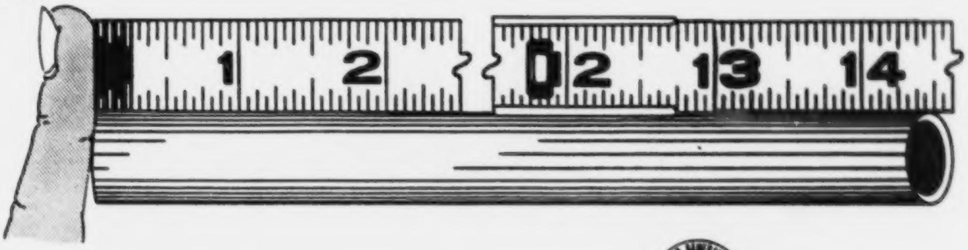
PROCEDURE

Functional Reading
- Follow written instructions
- Interpret graphics and symbols

Math Application
- Use English and metric measures

	Yes	No
1. Put on safety equipment.	___	___
2. Place pipe in suitable position for measuring and marking.	___	___
3. Determine correct measurement to be made.	___	___
4. Unfold rule and lay on top of pipe.	___	___
5. Place finger over end of pipe and butt rule against finger. (Figure 10)	___	___

FIGURE 10

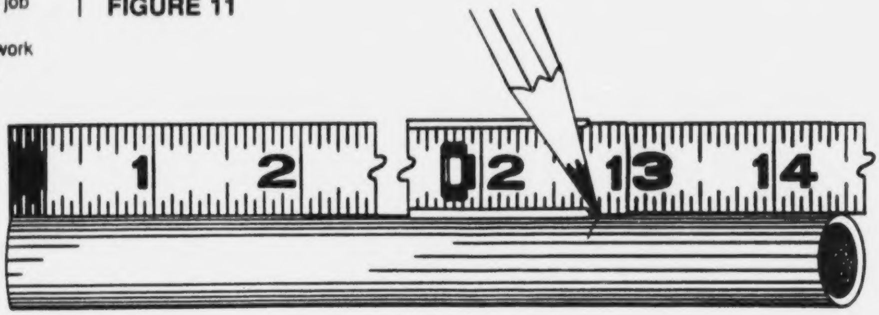


Functional Math
- Make measurements

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

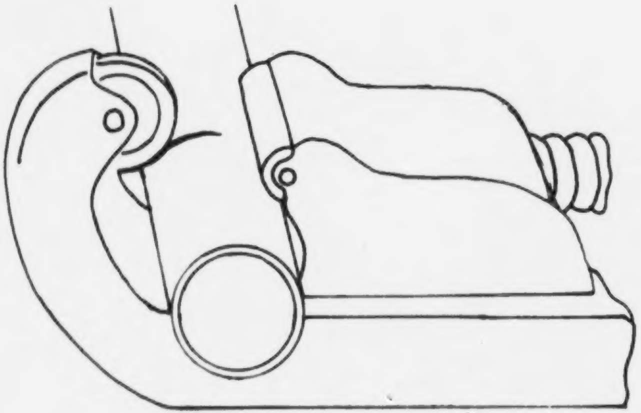
	Yes	No
6. Hold rule firmly on pipe and read specified measurement on rule.	___	___
7. Mark pipe at point of specified measurement. (Figure 11)	___	___

FIGURE 11



	Yes	No
8. Secure pipe in vise.	___	___
9. Open pipe cutter until it will fit over pipe.	___	___
10. Locate cutter wheel on the pencil mark. (Figure 12)	___	___

FIGURE 12

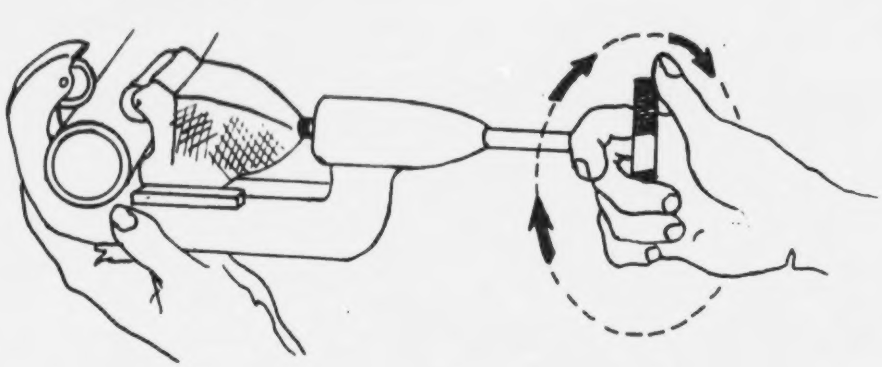


Yes No

11. Snug cutter up to pipe by rotating screw handle. (Figure 13) ___ ___

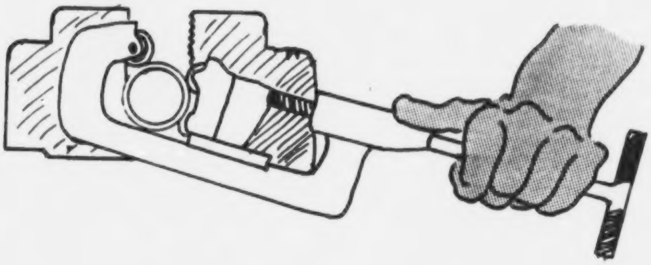
NOTE: Overtightening can break cutter wheel.

FIGURE 13



12. Rotate cutter counterclockwise to start groove. (Figure 14) ___ ___

FIGURE 14



	Yes	No
13. Tighten screw handle ¼ of a turn for each full revolution around the pipe.	___	___

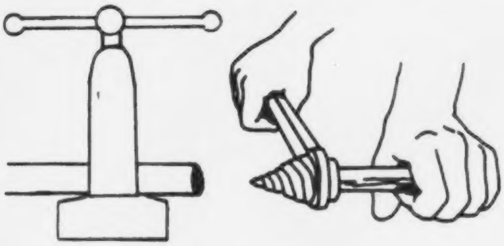
NOTE: Overtightening can cause cutters to break.

	Yes	No
14. Continue rotating cutter counterclockwise and tightening screw handle until pipe is cut.	___	___

CAUTION: When cutting short pieces of pipe, be careful not to cut your arm while rotating the cutter around the pipe.

	Yes	No
15. Clean pipe and cutter with shop towel.	___	___
16. Insert reamer tip in pipe. (Figure 15)	___	___

FIGURE 15

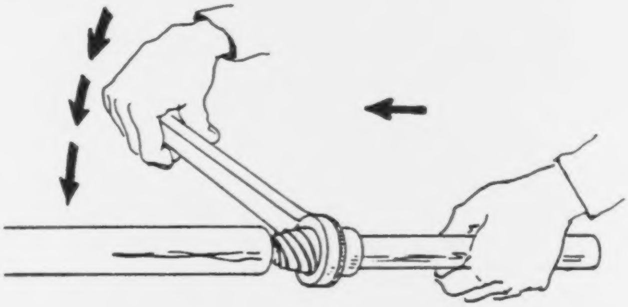


	Yes	No
17. Apply light forward pressure to push reamer into pipe.	___	___

	Yes	No
18. Start rotating reamer. (Figure 16)	___	___

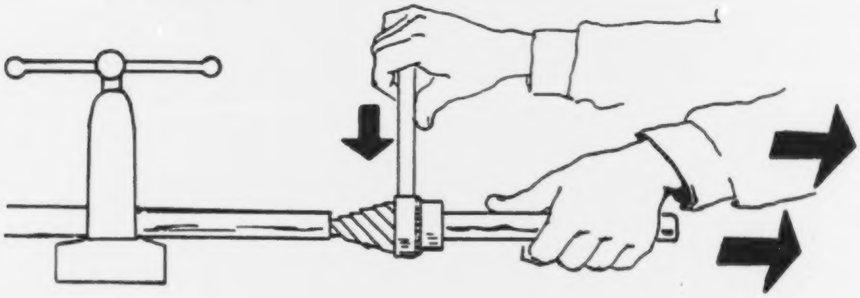
NOTE: Reamer should bite instantly if proper pressure is applied. Reamer can be damaged if rotated in the wrong direction.

FIGURE 16



19. Rotate reamer until burrs are removed. (Figure 17)	___	___
20. Pull reamer back while continuing to rotate. (Figure 17)	___	___

FIGURE 17



Yes No

21. Clean reamer with shop towel. ___ ___

22. Place drip pan under vise and end of pipe. ___ ___

23. Lubricate end of pipe with cutting oil. ___ ___

24. Secure and position ratchet die in die stock. ___ ___

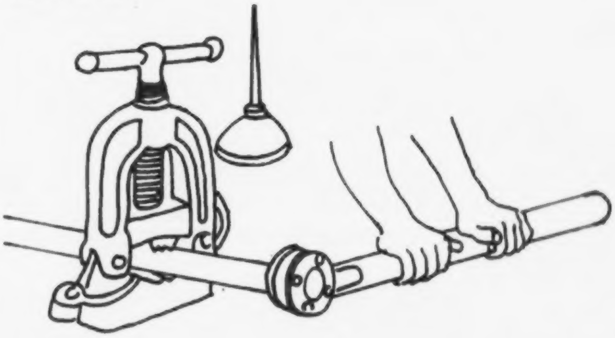
25. Place die on pipe. ___ ___

26. Start die straight on the pipe. ___ ___

27. Press die on pipe evenly and turn the die. (Figure 18) ___ ___

NOTE: Be sure the die cuts deep treads. The use of dull dies will result in shallow treads and could cause piping leaks.

FIGURE 18



28. Continue to apply cutting oil while turning the die. ___ ___

NOTE: Metal drip pan is used to catch dripping oil and steel cuttings.

	Yes	No
29. Continue turning pipe die and cutting threads until the desired amount of threads have been cut.	___	___
30. Reverse ratchet by turning lock 180 degrees, and remove die by turning counterclockwise.	___	___
NOTE: Hold onto the die stock firmly while removing it, otherwise, die stock might fall when it comes to the end of the threads.		
31. Clean threads with a wire brush.	___	___

⚠ **CAUTION:** Do not use compressed air for cleaning.

	Yes	No
32. Have instructor check your work.	___	___
33. Clean up area and put away tools and equipment.	___	___

(End of Job Sheet)

SKILL TEST RECORD

EVALUATOR'S COMMENTS ______________________________

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Correct length (±1/16")	4	3	2	1
Care taken when rotating cutter	4	3	2	1
Pipe end well reamed	4	3	2	1
Used oil to thread	4	3	2	1
Pipe threads cut properly	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

OBJECTIVE 8 **Make a flare with a compression-type flaring block.**

INTRODUCTION This job sheet will allow you to practice cutting, reaming, and flaring copper tubing.

TOOLS AND EQUIPMENT

- Hard hat and safety goggles
- Tubing cutter/reamer
- Compression-type flaring block
- Flaring tool
- Folding rule
- Refrigeration oil
- ¾″ copper tubing (soft rolled)
- One ⅜″ flare nut

PROCEDURE

Yes No

1. Put on safety equipment. ___ ___
2. Unroll a section of copper tubing. ___ ___
3. Measure and mark a 6″ piece of the copper tubing. ___ ___
4. Cut off tubing at the 6″ mark.
    a. Place cutter on tubing; do not overtighten. ___ ___
    b. Turn a few revolutions and then tighten a little more. ___ ___

Functional Reading
- Follow written instructions
- Interpret graphics and symbols

Math Application
- Use English and metric measures
- Make measurements

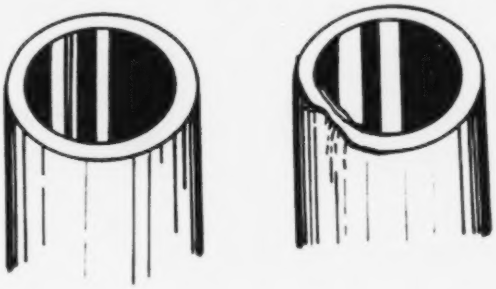
Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

Yes No

c. Continue to tighten a little bit at a time while turning the cutter until the tubing is cut. ___ ___

NOTE: Cutter should not be so tight that it bends the end of the tubing. (Figure 19)

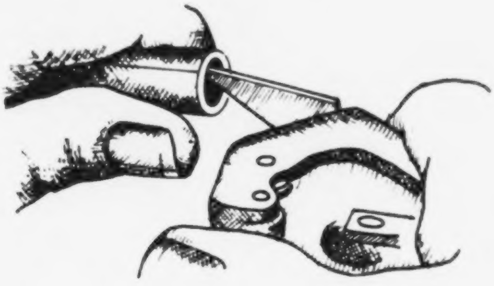
FIGURE 19



5. Reseal the end of the roll of tubing. ___ ___

6. Ream the cut piece of tubing. (Figure 20) ___ ___

FIGURE 20



Yes No

a. Don't overream; only remove the burrs. ___ ___

b. Point end of tubing slightly downward while reaming to let chips fall out. ___ ___

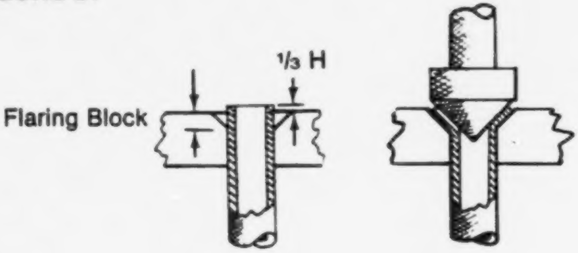
CAUTION: Do not blow into the end of the tubing. Eye injuries can result.

---

7. Place tubing in flaring block. ___ ___

8. Extend tubing above the block ⅓ the depth of the block chamfer. (Figure 21) ___ ___

FIGURE 21



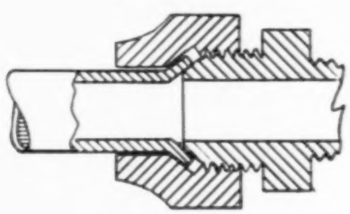
9. Place flaring tool on block. ___ ___

10. Put a drop of refrigeration oil on the threads and a drop on the cone. ___ ___

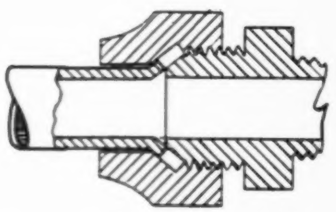
    NOTE: Refrigeration oil should always be used when working with refrigeration-system components.

	Yes	No
11. Tighten cone into tubing a few turns, reverse to back out the cone.	___	___
12. Continue the tightening and loosening process until the flare is made.	___	___
13. Do not overtighten the flaring tool.	___	___
NOTE: Overtightening will cause the tubing to wash out and may cause the flare to split, resulting in a bleed.		
14. Remove tubing from flaring block.	___	___
15. Place flare nut on the tubing.	___	___
16. Check fit of flare in the seat of the flare nut. (Figure 22)	___	___

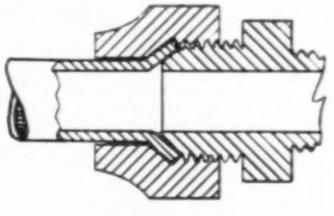
FIGURE 22



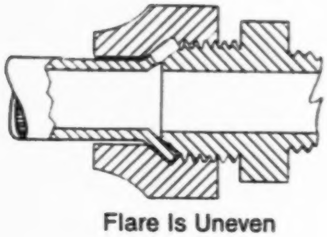
Properly Made Flare



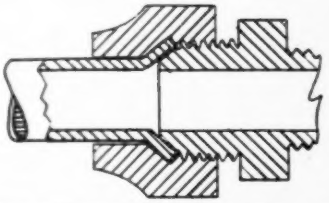
Flare Too Small



Flare Too Large



Flare Is Uneven



Tubing Was Not Reamed Before Flaring

	Yes	No
17. Have instructor inspect work.	___	___
18. Keep tubing for next job sheet.	___	___
19. Clean up area and put tools away.	___	___

(End of Job Sheet)

SKILL TEST RECORD

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Tubing cut the correct length (±1/16")	4	3	2	1
End of tubing not cracked	4	3	2	1
Burrs removed	4	3	2	1
Flare fit properly	4	3	2	1

EVALUATOR'S COMMENTS

____

____

____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

OBJECTIVE 9 **Make a 90-degree bend in copper tubing.**

INTRODUCTION

During this exercise you will be using a lever-type tubing bender to practice bending copper tubing. Other bending tools can be used—all with the goal of bending the tubing without flattening or kinking.

TOOLS AND EQUIPMENT

- Hard hat and goggles
- Tubing cutter
- ⅜" lever-type tubing bender
- ⅜" o.d. soft drawn copper tubing
- Steel tape or folding rule

PROCEDURE

	Yes	No
1. Put on safety equipment.	___	___
2. Unroll a straight piece of copper tubing.	___	___
3. Measure and mark a 17" piece of tubing.	___	___
4. Cut off tubing at the 17" mark.	___	___
5. Place bender on tubing.	___	___
6. Measure in 7" from one end on tubing and make a mark.	___	___
7. Align "R" mark on bender with mark on tubing. (Figure 23)	___	___

Functional Reading
- Follow written instructions
- Interpret graphics and symbols

Math Application
- Use English and metric measures

Functional Math
- Make measurements

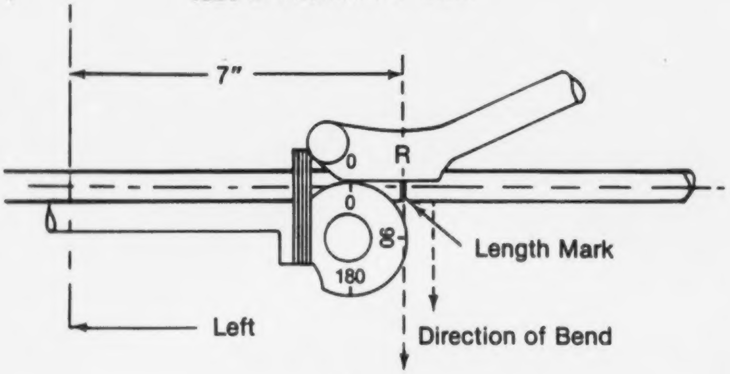
Job Acquisition/ Development

- Master specific job task/procedure
- Practice good work habits/attitudes

Yes No

FIGURE 23

Tube In Position For Bend



8. Observe how the bender fits on the tubing. (Figure 23) ___ ___

9. Pull lever until "R" mark aligns with 90-degree mark on bender. ___ ___

   NOTE: Tubing will stretch approximately one tube diameter for each 90-degree of bend.

10. Remove bender. ___ ___

11. Have instructor inspect work. ___ ___

12. Clean up your work area and put tools away. ___ ___

(End of Job Sheet)

SKILL TEST RECORD

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Pipe cut to proper length (±1/16")	4	3	2	1
Pipe positioned properly in bender	4	3	2	1
Pipe bend to proper angle (±2 degrees)	4	3	2	1
No flattened area in tubing	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

JOB SHEET 4 — HVAC APPLIED SKILLS — A 3

OBJECTIVE 10

Cut, ream, and join copper tubing using the sweat method.

INTRODUCTION

Copper tubing is the most popular piping used in HVAC systems. This exercise will give you practice in joining copper tubing using the sweat method.

TOOLS AND EQUIPMENT

- Fire extinguisher
- Colored safety glasses and hard hat
- Leather gloves
- Tubing cutter/reamer
- Steel tape or folding rule
- Sand cloth (emery cloth)
- Flux
- Torch and accessories
- Gas tank with wrench
- Striker
- Wire solder
- Dry wiping cloth
- Tubing
- Fitting
- Eye wash (acid neutralizing)

PROCEDURE

Functional Reading
- Follow written instructions
- Interpret graphics and symbols

	Yes	No
1. Ensure eye wash and fire extinguisher are adjacent to your work area.	___	___
2. Put on safety equipment.	___	___
3. Measure, mark, and cut tubing to desired length.	___	___
4. Ream end of cut tubing.	___	___

Math Application
- Use English and metric measures

Functional Math
- Make measurements

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

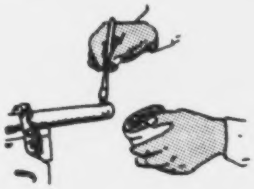
Yes No

5. Smooth tubing end with sand cloth. ___ ___

6. Clean fitting socket with sand cloth. ___ ___

7. Apply thin coat of flux to tubing end and fitting socket. (Figure 24) ___ ___

FIGURE 24



8. Insert tubing end into fitting socket. ___ ___

NOTE: Twist the tubing while inserting to spread the flux evenly.

9. Wipe away excess flux with dry cloth. ___ ___

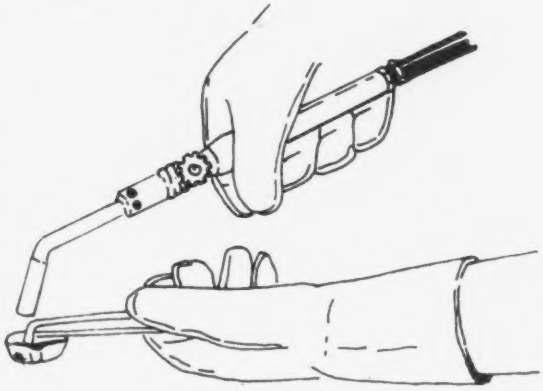
10. Secure tubing and fitting in vise carefully. ___ ___

11. Put on leather gloves. ___ ___

	Yes	No
12. Light and adjust torch. (Figure 25)	___	___

NOTE: Always use a striker.

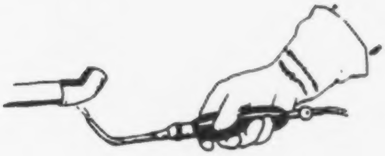
FIGURE 25



13. Apply heat to fitting. (Figure 26)	___	___

NOTE: The inner blue cone of the flame should be about ⅛" from the fitting.

FIGURE 26



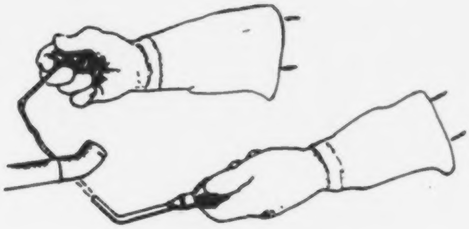
Yes No

14. Move the torch flame around the entire joint. ___ ___

15. Apply solder. (Figure 27) ___ ___

NOTE: Amount of solder is determined by size of tubing, i.e., ½" tubing will need approximately ½" wire solder, and ¾" tubing needs ¾" wire solder.

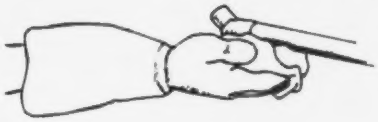
FIGURE 27



16. Discontinue heat and solder application when solder flows from joint. ___ ___

17. If necessary, wipe off excess solder with clean, dry cloth. (Figure 28) ___ ___

FIGURE 28



	Yes	No
18. Turn off torch.	___	___
19. Allow solder to cool. **NOTE:** Do not apply water to cool the fitting.	___	___
20. Have instructor check your work.	___	___
21. Clean up work area and put tools away.	___	___

(End of Job Sheet)

SKILL TEST RECORD

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Observed safety guidelines	4	3	2	1
Tubing cut to proper length (±$\frac{1}{16}$")	4	3	2	1
Soldered with smooth and closed joint	4	3	2	1

EVALUATOR'S COMMENTS

____

____

____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

OBJECTIVE 11

Cut, ream, and join plastic pipe.

INTRODUCTION

Plastic pipe is most commonly used in water supply lines, venting, and condensate drains for HVAC systems. This exercise will provide experience in cutting, reaming, and joining plastic pipe.

TOOLS AND EQUIPMENT

- Rubber gloves
- Hard hat and goggles
- Pipe cutter or handsaw with miter box
- Reamer or knife
- Cleaning solvent with brush or abrasive paper
- Solvent cement with brush
- PVC pipe
- PVC fittings
- Wiping cloth
- Flexible plastic pipe
- Plastic insert fittings
- Clamps
- Screwdriver
- Socket wrench

PROCEDURE

Functional Reading
- Follow written instructions
- Interpret graphics and symbols

Yes No

1. Put on hard hat and goggles. ___ ___

2. Procedure for PVC pipe.

   a. Measure and cut pipe off squarely to desired length. ___ ___

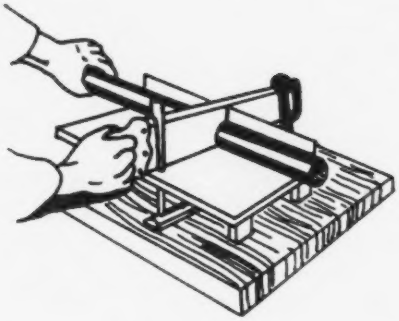
Math Application
- Use English and metric measures

Functional Math
- Make measurements

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

Yes No

FIGURE 29



b. Ream pipe with reamer or knife. ___ ___

CAUTION: Since most PVC reaming is done with a pocket knife or other type of knife, care must be used in this operation.

---

c. Apply solvent cleaner to pipe end and fitting socket. ___ ___

d. Wipe solvent cleaner from the pipe end and fitting socket. ___ ___

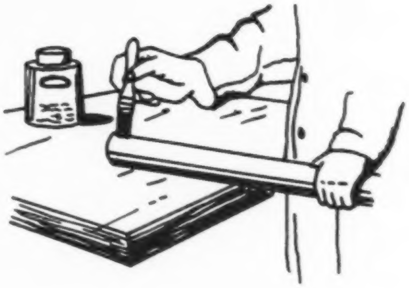
NOTE: This cleans the pipe and removes the gloss for better bonding.

Yes No

e. Put on rubber gloves and apply a light, even coat of solvent cement to the pipe end and fitting socket. (Figure 29) ___ ___

NOTE: Consult the MSDS sheet for further safety concerns.

FIGURE 30

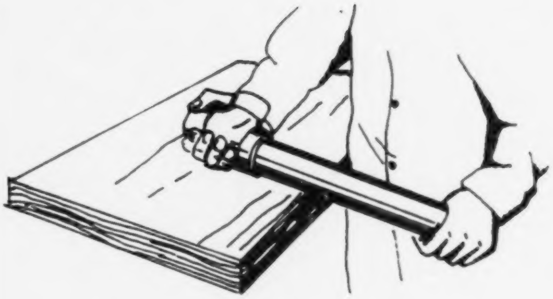


f. Insert pipe all the way into the fitting socket while giving it a quarter turn. (Figure 30) ___ ___

NOTE: This operation must be done quickly because the cement sets up in a few seconds.

Yes No

FIGURE 31



g. Consult manufacturer's recommendations for cement drying times. ___ ___

h. Have instructor check your work. ___ ___

i. Clean up area and put away tools. ___ ___

3. Procedure for flexible plastic pipe

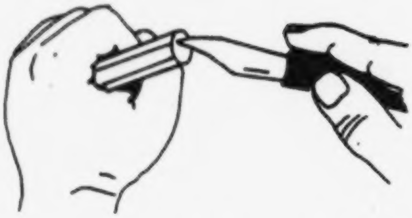
    a. Measure and cut pipe to desired length. ___ ___

    b. Ream pipe using a reamer or knife. (Figure 31) ___ ___

CAUTION: Since most flexible plastic pipe is cut and reamed with a knife, care must be used in this operation. Some companies require special gloves be worn when working with sharp objects.

Yes No

FIGURE 32



c. Slip clamp over end of pipe. ___ ___

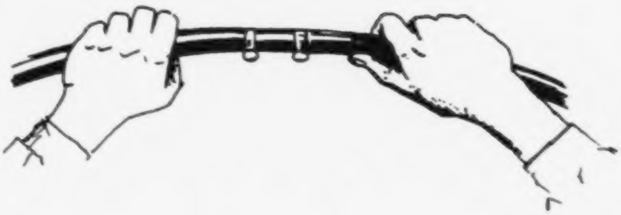
NOTE: Open clamp enough for it to fit loosely on the pipe.

d. Hold pipe in one hand and the fitting in the other, and force fitting into end of pipe. (Figure 32) ___ ___

NOTE: Cold (rigid) or heavy gauge pipe may need to be softened with hot water or a small flame from a torch.

Yes No

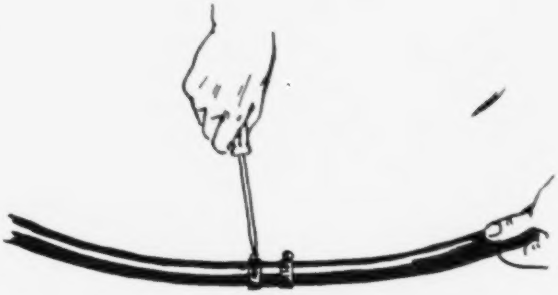
FIGURE 33



e. Slip clamp over inserted fitting and tighten with screwdriver. (Figure 33) ___ ___

NOTE: Some clamps are fitted with hex nuts to accommodate socket wrenches.

FIGURE 34



		Yes	No
f.	Complete the same process on other end of fitting.	___	___
g.	Have instructor check your work.	___	___
h.	Clean up area and put tools away.	___	___

(End of Job Sheet)

SKILL TEST RECORD

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Pipe cut to proper length (±1/16")	4	3	2	1
Pipe end cut square	4	3	2	1
Pipe inserted fully into fitting	4	3	2	1
Clamps properly placed and tightened	4	3	2	1

EVALUATOR'S COMMENTS

____

____

____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** — Can perform job with no additional training

3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required

2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill

1 **Unskilled** — Is familiar with process, but is unable to perform job

WRITTEN TEST

HVAC APPLIED SKILLS A 3

Name ______________________________ Score __________

OBJECTIVE 1

Given a list of terms associated with HVAC skills, match them to their correct definitions. Write the letter that corresponds to the most correct answer.

_____ 1. A device used to measure and control the air temperature in an HVAC system is a

a. plenum
b. thermostat
c. damper
d. duct

_____ 2. Moisture produced when air is rapidly cooled is

a. beading
b. absorption
c. inversion
d. condensation

_____ 3. The term "450 fpm" means that air is moving past a point at 450

a. feet per minute
b. feet per mile
c. flow-past-meter
d. feet per meter

_____ 4. The sum of the negative and positive static pressures being exerted by a blower is called

a. system pressure
b. cfm
c. plenum force
d. friction pressure

May be photocopied for student use.

_____ 5. The reduction in air pressure in a duct system due to type, size, and length of ductwork is

a. static pressure
b. damper loss
c. friction loss
d. system losses

_____ 6. The speed of air movement measured in feet per minute is

a. system pressure
b. outlet volume
c. system output speed
d. air velocity

_____ 7. The actual length plus the equivalent length of ducts is called

a. measured length
b. effective length
c. system capacity
d. takeoff distance

_____ 8. A valve in the ductwork that maintains the desired air flow or air balance is a/an

a. takeoff
b. air vent
c. damper
d. plenum

_____ 9. The first fitting or air chamber off of an HVAC unit which receives the air from the blower and distributes it in the trunkline is a

a. plenum
b. flue
c. takeoff
d. damper chamber

May be photocopied for student use.

_____10. The point of departure from a duct to which a duct fitting is attached for branching of ductwork is a

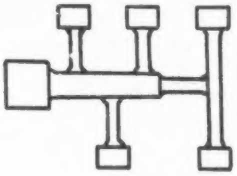
- a. tee
- b. takeoff
- c. plenum
- d. damper junction

_____11. The main supply duct in a forced air system is a

- a. branch
- b. main
- c. trunkline
- d. central air main

OBJECTIVE 2 **Identify types of supply duct systems.**

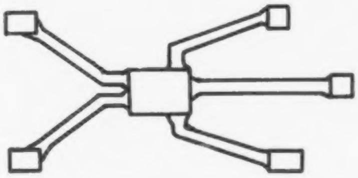
_____ 1. The type of supply duct shown below is a



- a. radial or spider system
- b. perimeter loop trunk duct
- c. trunk and branch extended
- d. trunk and branch reducing plenum system

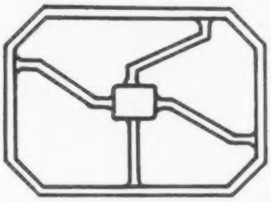
May be photocopied for student use.

_____ 2. The type of supply duct system pictured below is a



a. radial or spider system
b. perimeter loop trunk
c. trunk and branch
d. extended plenum

_____ 3. The picture below represents a



a. circle loop duct
b. perimeter loop radial duct
c. trunk and branch duct
d. overlapped loop duct

OBJECTIVE 3 **Given alternatives, choose the major factors affecting HVAC duct system performance.**

_____ 1. Which of the following factors is NOT a consideration in duct system performance?

a. Duct length
b. Duct diameter
c. Air flow
d. Compressor size

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_____ 2. The effective length of a duct is computed by adding the actual length to the

a. actual length
b. assumed length
c. equivalent length
d. overall length

_____ 3. Insulation that reduces heat gain or loss in air passing through ducts is called

a. duct wrap
b. condensate foil
c. duct cover
d. fiber wrap

_____ 4. Air flow in an HVAC system is produced by the

a. compressor
b. ductwork
c. evaporator
d. fan or blower

_____ 5. The recommended air velocity from a floor diffuser is

a. 1000 fpm
b. 700 fpm
c. 450 fpm
d. 100 fpm

_____ 6. Air filters that clog with dust particles can

a. increase the air flow through ducts
b. limit the efficiency of a HVAC system and freezes coils
c. cause condensate to form outside ductwork
d. increase fpm of every outlet and freezes coils

May be photocopied for student use.

_____ 7. Duct diameter is determined by

a. the size required to maintain the specified system pressure and the air velocity required at each outlet
b. the size of the HVAC compressor
c. the size required to keep the trunkline air flowing at 110 fpm
d. the number of ducts attached to the trunkline and the type of duct wrap used

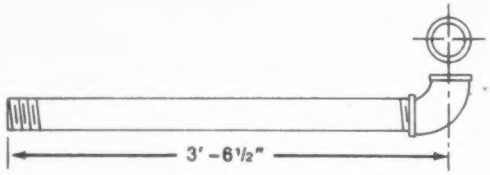
_____ 8. Resistance to air flow in ductwork is known as

a. volume loss
b. air loss
c. flow friction
d. effective resistance

OBJECTIVE 4

Name the methods used to measure piping used within an HVAC system.

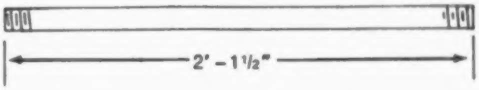
_____ 1. The method of pipe measuring shown below is



a. center-to-center
b. end-to-end
c. center-to-bend
d. end-to-center

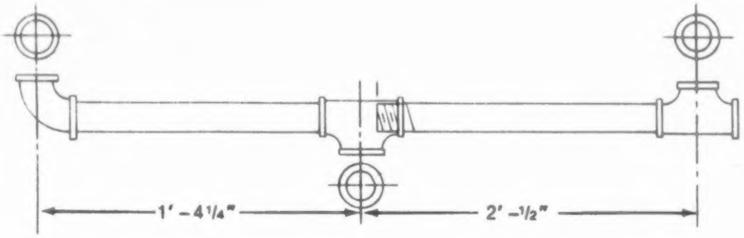
May be photocopied for student use.

_____ 2. The drawing below represents which method of pipe measuring?



a. Center-to-center
b. End-to-center
c. Center-to-end
d. End-to-end

_____ 3. The method of pipe measuring shown below is



a. end-to-center
b. center-to-center
c. end-to-end
d. end-to-middle

May be photocopied for student use.

WRITTEN TEST ANSWERS

HVAC APPLIED SKILLS

A 3

OBJECTIVE 1

1. b
2. d
3. a
4. a
5. c
6. d
7. b
8. c
9. a
10. b
11. c

OBJECTIVE 2

1. d
2. a
3. b

OBJECTIVE 3

1. d
2. c
3. a
4. d
5. c
6. b
7. a
8. c

OBJECTIVE 4

1. d
2. d
3. b

OBJECTIVES 5-11

Evaluated through the use of assignment sheets and job sheets.

CIMC
TEST CODE SHEET

VOCATIONAL PROGRAM (BOOK TITLE) INTRODUCTION TO HVAC

UNIT NUMBER AND TITLE – A3 – HVAC APPLIED SKILLS

TOTAL NUMBER OF TEST QUESTIONS 25

TOTAL NUMBER OF BASIC SKILL QUESTIONS 8

OBJECTIVE NUMBER	TEST QUESTION NUMBER(S)	BASIC SKILL CODE(S)
1	**1, 8-11**	**X**
1	**2-6**	**S**
1	**7**	**M**
2	**1-3**	**X**
3	**1, 3-7**	**X**
3	**2**	**M**
3	**8**	**S**
4	**1-3**	**X**
5-11	**Evaluated on Assignment Sheets**	

INTRODUCTION TO HEATING, VENTILATION, AND AIR CONDITIONING COMPETENCY PROFILE

Student ______________________________ Soc. Sec. No. ______ – ______ – ______
Last First MI

PROGRAM ______ Grade 9 10 11 12 Adult SCHOOL ______

INSTRUCTOR ______ SCHOOL ADDRESS ______ PHONE ______

STUDENT'S HOME ADDRESS ______ DATE OF BIRTH ______ PHONE ______

STUDENT'S EMPLOYER ______ ADDRESS ______ PHONE ______

CONTACT IN CASE OF EMERGENCY ______ PHONE ______

ADDRESS ______

OR ______

ADDRESS ______ PHONE ______

The above information can be used for school records and/or to ensure safety of students. This confidential information is not to be released to employers or to the general public.

ON-THE-JOB TRAINING/WORK EXPERIENCE

DURATION OF EMPLOYMENT	JOB TITLE	EMPLOYER	SUPERVISOR'S NAME	ADDRESS OF EMPLOYER	PHONE

This agency does not discriminate on the basis of race, creed, color, national origin, sex, age, veteran status, qualified handicap, or disability.

Duplicate one copy for each student.

SPECIFIC JOB COMPETENCIES

DIRECTIONS: Evaluate the trainee using the rating scale below, and check the appropriate number to indicate the degree of competency. The numerical ratings of 4, 3, 2, 1, and 0 are not intended to represent the traditional school grading system of A, B, C, D, and F. The descriptions associated with each of the numbers focus on level of student performance for each of the tasks listed below.

Rating Scale:
4 — **Skilled** — can perform job independently with no additional training.
3 — **Moderately Skilled** — has performed job independently during the training program; limited additional training may be required.
2 — **Limited Practice** — has practiced job during training program; additional training is required to develop skill.
1 — **Exposure Only** — general information provided with no practice time; close supervision needed and additional training required.
0 — **No Exposure** — no information or practice provided during training program; complete training required.

UNIT A1

4	3	2	1	0	*HVAC Materials*
☐	☐	☐	☐	☐	1. Given a list of terms associated with HVAC materials, match them to their correct definitions.
☐	☐	☐	☐	☐	2. Given a block diagram, match the major components of a HVAC system to their functions.
☐	☐	☐	☐	☐	3. Select the correct application of piping types used in HVAC systems.
☐	☐	☐	☐	☐	4. Given drawings, match pipe fittings to their names.
☐	☐	☐	☐	☐	5. Match drawing of duct fittings to their correct title and uses.
☐	☐	☐	☐	☐	6. Match drawings of registers and diffusers to their titles.
☐	☐	☐	☐	☐	7. ______________________________

WRITTEN TEST SCORE ______________________________

UNIT A2

4	3	2	1	0	*HVAC Materials*
☐	☐	☐	☐	☐	1. Given a list of terms associated with HVAC tools and equipment, match them to their correct definitions.
☐	☐	☐	☐	☐	2. Choose guidelines for the safe use and care of HVAC tools and equipment.
☐	☐	☐	☐	☐	3. Given a drawing, match HVAC tools and equipment to their names.
☐	☐	☐	☐	☐	4. Read a circumference rule.
☐	☐	☐	☐	☐	5. Use inside and outside calipers.
☐	☐	☐	☐	☐	6. ______________________________

WRITTEN TEST SCORE ______________________________

UNIT A3

4	3	2	1	0	*HVAC Applied Skills*
☐	☐	☐	☐	☐	1. Given a list of terms associated with HVAC skills, match them to their correct definitions.
☐	☐	☐	☐	☐	2. Identify types of supply duct systems.
☐	☐	☐	☐	☐	3. Given alternatives, choose the major factors affecting HVAC duct system performance.
☐	☐	☐	☐	☐	4. Name the methods used to measure piping used in an HVAC system.
☐	☐	☐	☐	☐	5. Interpret HVAC symbols used on floor plans.
☐	☐	☐	☐	☐	6. Given specifications, calculate the piping sizes required to install an HVAC system.
☐	☐	☐	☐	☐	7. Cut, ream, and thread a specified length of steel pipe.
☐	☐	☐	☐	☐	8. Make a flare with a compression-type flaring block.
☐	☐	☐	☐	☐	9. Make a 90-degree bend in copper tubing.
☐	☐	☐	☐	☐	10. Cut, ream, and join copper tubing using the sweat method.
☐	☐	☐	☐	☐	11. Cut, ream, and join plastic pipe.
☐	☐	☐	☐	☐	12. ______________________________

WRITTEN TEST SCORE ______________________________

Use of This Document

Use of this document can be used to record information about the student and the skills mastered by the student. This information is useful in documenting student progress during the training program and to provide information about the student's qualifications to potential employers and for entry into advanced training programs. Instructors using AGC-CIMC instructional materials are authorized to reproduce this document as required for use in their training programs.

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INTRODUCTION TO HEATING, VENTILATION, AND AIR CONDITIONING

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READING SKILLS

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UNITS OF INSTRUCTION

Reading Skills — Reading Comprehension

UNITS OF INSTRUCTION	Gain factual information	Distinguish fact, opinion and inference	Recognize stereotyping and bias	Recognize propaganda	Analyze cause and effect	Draw conclusions	Make generalizations	React to written material	Apply word analysis techniques
1. HVAC Materials									
2. HVAC Tools and Equipment									
3. HVAC Applied Skills									

Reading Skills — Research and Reference

UNITS OF INSTRUCTION	Select useful resources	Locate resources	Find materials in library	Use standard references	Use in-book reference tools	Use audiovisual media	Use computer data base	Use magazines and newspapers
1. HVAC Materials								
2. HVAC Tools and Equipment								
3. HVAC Applied Skills								

Reading Skills — Functional Reading

UNITS OF INSTRUCTION	Interpret forms and records	Follow written instructions	Interpret graphics and symbols	Use content area vocabulary	Interpret abbreviations/acronyms	Read aloud
1. HVAC Materials				●		
2. HVAC Tools and Equipment		●		●		
3. HVAC Applied Skills		●	●	●		

Language

UNITS OF INSTRUCTION	Use standard grammar and correct spelling, punctuation, and capitalization	State ideas clearly
1. HVAC Materials		
2. HVAC Tools and Equipment		
3. HVAC Applied Skills		

Composition

UNITS OF INSTRUCTION	Use complete sentences	Develop preliminary outline	Use topic sentences	Use introductory/closing paragraphs	Compose reports	Compose essays	Proofread and edit	Construct graphics and symbols	Take notes
1. HVAC Materials									
2. HVAC Tools and Equipment									
3. HVAC Applied Skills									

C BASIC SKILLS DOCUMENTATION MATRI

NG SKILLS

MATH SKILLS

Research				Functional Writing							Operation and Calculation														Math Application											Data Analysis and Display												
Use notecards	Create bibliography	Use footnotes	Outline material	Complete forms and records	Write instructions	Write letters	Write job applications	Write resumes	Use word processing	Use computer graphics	Round off numbers	Estimate answers	Use scientific notations	Use exponential notations	Calculate with whole numbers	Calculate with fractions	Calculate with decimals	Convert whole numbers to fractions	Convert whole numbers to decimals	Solve numerical expressions	Solve formulae and equations	Obtain squares and square roots	Convert units of measure	Perform metric calculations	Solve word problems	Select/apply mathematical formula	Select/apply mathematical procedure	Use English and metric measures	Solve time/rate/distance problems	Solve ratio/proportion problems	Solve percent problems	Apply techniques of scaling	Apply algebra principles	Apply geometry principles	Apply trigonometry principles	Interpret charts and tables	Interpret graphs (type)	Collect /record data	Apply sampling techniques	Apply principles of probability	Construct charts and tables	Construct graphs	Calculate statistics	Interpret statistics	Interpret blueprints/plans	Make measurements	Perform banking transactions	
																●												●																		●		
																												●																	●	●		

RIX

SCIENCE SKILLS

95-010910

Functional Math														General Science									Life Science							Physical Science					Earth Science							
Make measurements	Perform banking transactions	Make change	Solve practical problems	Calculate gross earnings	Solve income/expense problems	Prepare a budget	Calculate interest	Solve interest problems	Calculate sales tax	Determine income tax	Use calculator for computation	Use computer for computation	Use computer spreadsheets	Apply computing skills	Apply scientific method of inquiry	Conduct experiments	Investigate science ethics	Investigate science history	Investigate/apply economics in technology	Use scientific instruments	Investigate/apply technology	Collect specimens	Identify/classify living organisms	Investigate biological history of the earth	Investigate food chains, webs, pyramids	Investigate/apply principles of human development	Investigate/apply principles of genetics/heredity	Investigate/apply principles of anatomy/physiology	Investigate health issues	Analyze/classify matter	Investigate forms/changes of matter	Investigate forms/changes of energy	Investigate/apply chemical properties	Investigate/apply physical laws	Investigate physical characteristics of the earth	Investigate geological history of the earth	Investigate physical forces acting on the earth	Solve problems of longitude, latitude, and time zones	Investigate conservation of physical resources	Investigate conservation of living resources	Investigate issues of environmental impact	Apply science principles to environmental issues
●																				●																						
●																																										

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ORAL COMMUNICATION SKILLS

INTERPERSONA SKI

UNITS OF INSTRUCTION	Oral Presentation									Listening				Interactive Communication										General Relating										
	Make informative presentations	Make persuasive presentations	Present personal opinion/viewpoint	Use good speaking techniques	Select/use words effectively	Use effective body language	Present approriate appearance	Integrate audio and/or visual materials in oral presentations	Adapt presentation to specific audience	Apply active listening skills	Distinguish fact, opinion, and inference	Draw conclusions/make generalizations	Analyze/identify point of view	Give/follow oral directions	Apply questioning techniques	Conduct/receive interviews	Analyze/apply nonverbal communication	Work effectively in a group	Communicate with clients/customers/patients	Communicate with co-workers	Communicate with supervisors	Communicate with professional colleagues/associates	Apply telephone etiquette	Investigate/apply communication process models	Analyze/apply nonverbal communication	Investigate/apply cross-cultural communication	Interact with co-workers	Interact with supervisors	Interact with clients/customers/patients	Interact with professionalcolleagues/associates	Interact with family/friends	Participate in group activities	Participate in industrial relations/functions	Identify personal values/attitudes
1. HVAC Materials																																		
2. HVAC Tools and Equipment																																		
3. HVAC Applied Skills																																		
* Use this line for entering your state or local codes for graduation requirements or learner outcomes.																																		

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Developer of the Nation's

SONAL OR RELATING SKILLS																									CREATIVE THINKING/ PROBLEM SOLVING SKILLS																						
			Teamwork/ Cooperation															Leadership/ Influence							Cognitive Activities																				Job Se Selec		
Participate in industrial relations functions	Identify personal values/attitudes	Apply information to life experiences	Identify values/attitudes	Identify needs/drives	Select/apply appropriate behavior	Investigate/identify personal styles	Investigate/identify group/corporate climate	Give/receive feedback	Identify hidden purposes	Investigate/apply group dynamics	Control undesirable/inappropriate behavior	Resolve conflicts	Clarify goals/objectives	Devise "win/win" situations	Build consensus	Generate ideas	Present point of view	Analyze/apply leadership styles	Analyze/apply management styles	Obtain confidence of others	Develop esteem in self/others	Persuade others	Analyze/apply motivation techniques	Provide positive coaching	Collect/record information	Identify critical elements/issues	Define a problem	Identify underlying causes	Apply a problem-solving model	Analyze/synthesize information	Identify/analyze underlying assumptions	Draw conclusions	Predict results/outcomes	Identify/evaluate consequences	Identify/develop alternatives	Evaluate alternatives	Select an alternative	Devise a solution	Create a finished product	Apply intuitive/creative thinking processes	Transfer knowledge/training to new situations	Apply new technology	Develop an action plan	Evaluate results/outcomes	Analyze personal occupational aptitudes/preferences	Investigate employment prospects of a career field/occupation	Investigate training requirements for a career field/occupation

EMPLOYABILITY SKILLS

Job Search/ Selection							Job Aquisition/ Development													
career field/occupation	Investigate training requirements for a career field/occupation	Investigate benefits of a career field/occupation	Compare/evaluate career options	Develop personal career path	Locate appropriate jobs	Analyze duties/requirements/benefits of specific job	Master specific job task/procedure	Fill in job-related applications	Write letter of application	Write personal resume	Interview for a job	Apply business etiquette	Practice good work habits/attitudes	Develop good personal presentation	Develop self-confidence/esteem	Develop effective leadership	Deal effectively with supervisors	Deal effectively with co-workers	Deal effectively with professional colleagues/associates	Deal effectively with customers/clients
							●						●							

SOCIAL STUDIES SKILLS

Information Analysis						Social Studies Application										Functional Social Studies														
Collect/record data	Interpret graphical information	Construct graphical information	Interpret maps/globes	Interpret statistical information	Analyze/interpret demographic information	Investigate/apply U.S. history	Investigate/apply world history	Investigate/apply U.S. geography	Investigate/apply world geography	Investigate/apply principles of government/politics	Investigate/apply principles of economics	Investigate/apply principles of ethics	Investigate/apply principles of psychology	Investigate/apply principles of sociology	Investigate/apply cross-cultural studies	Practice responsible personal economics	Prepare a personal budget	Use credit responsibly	Practice good work ethics	Participate in industrial relations	Interact with people of different races/cultures	Investigate/participate in government	Investigate/apply American legal practices	Select/use sources of information on current events	Analyze current events	Analyze consumer issues	Analyze social issues	Analyze conservation/ecology issues	Analyze social impact of science/technology	Analyze economic impact of science/technology

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